BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF DELAWARE

IN THE MATTER OF THE APPLICATION OF DELMARVA POWER & LIGHT COMPANY FOR APPROVAL OF A PROGRAM FOR PLUG IN VEHICLE CHARGING (FILED OCTOBER 19, 2017)	))))))	PSC DOCKET NO. 17-1094

DELMARVA POWER & LIGHT COMPANY'S SUBMISSION IN SUPPORT OF HEARING EXAMINER'S RULING ON PROCEDURAL SCHEDULE

Applicant Delmarva Power & Light Company ("Delmarva") supports the Findings and Recommendations issued by Senior Hearing Examiner Mark Lawrence on July 11, 2018, stating as follows:

BACKGROUND

1. Public service commissions across the country are addressing the electrification of our transportation system and its impact on their distribution systems and ratepayers. On October 19, 2017, Delmarva filed an application (the "Application") with the Public Service Commission (the "Commission"), seeking approval of a modest program related to and in anticipation of what many experts believe will be a significant increase in the number of electric vehicles in Delaware.

2. Since the Application was filed, the Commission empowered a hearing examiner to manage the case. Specifically, on February 1, 2018, the Commission

issued Order No. 9183 designating Senior Hearing Examiner Mark Lawrence as hearing examiner for this matter, and in so doing, the Commission noted as follows:

> WHEREAS, on November 30, 2017 in Order No. 9150, the Commission opened this docket and designated R. Campbell Hay as Hearing Examiner[1] for this matter pursuant to the terms of 26 Del. C. § 502 and 29 Del. C. ch. 101 *to schedule and conduct*, upon due notice, such public comment sessions and evidentiary hearings, as may be necessary, *to have a full and complete record concerning the justness and reasonableness of the proposed program*;

Order No. 9183, PSC Docket No. 17-1094 (Feb. 1, 2018) (emphasis added). In designating Senior Hearing Examiner Mark Lawrence, the Commission empowered the Hearing Examiner "*to continue the assigned responsibilities* in this docket, as may be necessary, *to have a full and complete record concerning the justness and reasonableness of the proposed program*." *Id.* (emphasis added).

3. The case has been well managed, first by Hearing Examiner Campbell Hay and now by Senior Hearing Examiner Lawrence. Public hearings were held in all three counties and the parties have exchanged discovery and filed direct testimony. The evidentiary hearings were scheduled for July 11, 2018 and July 12, 2018.

[1] The Commission initially designated R. Campbell Hay as Hearing Examiner in this matter on November 30, 2017. Order No. 9150, PSC Docket No. 17-1094 (Nov. 30, 2017). Hearing Examiner Hay resigned in late January 2018, prompting the Commission to issue Order No. 9183.

4. On June 22, 2018, the undersigned counsel requested a continuance of the evidentiary hearings. (Continuance Request, Exhibit A). The reason for the request was that Delmarva expected to receive within 10-14 days a report issued by Gabel Associates, Inc., a consultant engaged by Delmarva's parent company, Exelon, to analyze the implications of electric vehicle market expansion in the various Exelon territories, including Delaware (the "Gabel Report" or the "Report"). Given the relevance of the Report to this case but the press of the procedural schedule, Delmarva requested a continuance so the parties would have ample time to review the Report and, to the extent necessary, submit discovery or supplemental testimony in advance of the evidentiary hearing. While Delmarva anticipated the Report would fall squarely within the scope of its planned rebuttal testimony, given the anticipated level of detail contained in the Report, Delmarva thought this approach (i.e., adding several weeks to the schedule) would be fairer to all parties than simply attaching it to rebuttal testimony with limited opportunity for the other parties to probe the methodologies and underlying assumptions supporting the analysis contained in the Report.

5. After reviewing written submissions on Delmarva's request and hearing argument from the parties on July 3, 2018, the Hearing Examiner granted the request and Delmarva agreed to file the Gabel Report by close of business July

6, 2018. The Hearing Examiner memorialized his ruling in the form of "Findings and Recommendations" dated July 11, 2018.[2]

6. In so ruling, the Hearing Examiner found that "no party will be prejudiced by the filing of this Report and the delay of the evidentiary hearings."[3] The Hearing Examiner also found the Gabel Report "contains a detailed analysis which will substantially aid the Commission in deciding this case" and further observed the report "is critical for the Commission to properly decide this case in a rapidly changing area of utility law."[4] The Hearing Examiner required that "[a]ny appeal of these Findings and Recommendations must be taken in accordance with Rule 2.16 of the Commission's Rules of Practice and Procedure."[5] On July 17, 2018, Hearing Examiner Lawrence ordered that all responses to the Findings and Recommendations be filed by July 31, 2018. Because DPA has represented that it plans to appeal the Hearing Examiner's ruling, Delmarva submits this memorandum in support of the Hearing Examiner's Findings and Recommendations.

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[2] *In the Matter of the Application of Delmarva Power & Light Company for Approval of a Program for Plug In Vehicle Charging*, Findings and Recommendations of the Hearing Examiner, Public Service Commission Docket No. 17-1094 (July 11, 2018) [hereinafter "Hearing Examiner Ruling"] (Attached hereto as Exhibit B).

[3] *Id.* at 8.

[4] *Id.*

[5] *Id.* at 9.

ARGUMENT

A. *DPA's Appeal Is Interlocutory Pursuant to Commission Rule 2.16.*

7. It is well established that appeals from rulings on discovery and scheduling issues are interlocutory. Black's Law Dictionary (10th ed. 2014) (defining interlocutory as "[s]omething intervening between the commencement and the end of a suit which decides some point or matter, but is not a final decision of the whole controversy"). This is true throughout Delaware's courts and administrative tribunal forums.[6] Yet, DPA argues the mere labeling of the Hearing Examiner's written memorialization of his oral ruling on Delmarva' continuance request as "Findings and Recommendations of the Hearing Examiner" takes the ruling outside the scope of Rule 2.16 of the Commission's Rules of Practice and Procedure regarding interlocutory appeals. This improperly elevates form over substance. Simply put, the label on the written document memorializing the Hearing Examiner's oral ruling is of little relevance; it is the substance of the ruling that

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[6] The Delaware Supreme Court has memorialized a well-settled policy and precedent around interlocutory appeals in Delaware, which are to be exceptional and expedited:

> (ii) *Interlocutory appeals should be exceptional, not routine, because they disrupt the normal procession of litigation, cause delay, and can threaten to exhaust scarce party and judicial resources.* Therefore, parties should only ask for the right to seek interlocutory review if they believe in good faith that there are substantial benefits that will outweigh the certain costs that accompany an interlocutory appeal.

Del. Sup. Ct. R. 42(b)(ii) (emphasis added).

matters. The underlying ruling involves scheduling and discovery issues, so Commission Rule 2.16 governs.

8. Applications for certification of an interlocutory appeal are granted "only in extraordinary circumstances." *O'Connor v. Petti*, 906 A.2d 807 (Table), 2006 WL 1538369, at *1 (Del. 2006). Consistent therewith, Rule 2.16.1 of Practice and Procedure of the Delaware Public Service Commission states, "Interlocutory appeals from rulings of the Presiding Officer or Hearing Examiner during the course of a proceeding may be taken to the full Commission by any party *only where extraordinary circumstances necessitate a prompt decision by the Commission to prevent substantial injustice or detriment to the public interest*." 26 *Del. Admin. C.* § 1001-2.16.1 (emphasis added). DPA cannot meet this high standard.

B. *No Extraordinary Circumstances Exist in this Case.*

9. No extraordinary circumstances exist here such that interlocutory review is necessary to prevent substantial injustice or detriment to the public interest. DPA argued to the Hearing Examiner that granting the continuance request would create a bad precedent, yet procedural schedules are often modified by Hearing Examiners in the exercise of their discretion. This seems especially appropriate when doing so advances the primary responsibility of the Hearing Examiner, to produce "*a full and complete record concerning the justness and reasonableness of*

the proposed program."[7] To that end, the Hearing Examiner specifically found the Gabel Report will help provide the Commission a more "full and complete" record to make the important decisions called for in this docket. To be clear, Delmarva proposed and the Hearing Examiner acknowledged that DPA and the other parties will be afforded the time needed to review and challenge the Gabel Report, so no party is prejudiced by the Hearing Examiner's decision. In short, the high burden for interlocutory relief cannot be met in this case. As such, the Commission should uphold the Hearing Examiner's Findings and Recommendations regarding the scheduling of this docket.

C. *The Gabel Report is Important to the Resolution of the Docket.*

10. Even if the Commission does not apply the interlocutory standard to this challenge to the Hearing Examiner's ruling, the decision to grant the continuance request and accept the Gabel Report should be affirmed. The timing of the Gabel Report is partially a product of the fact that issues around the electrification of the transportation grid are evolving quickly, as public service commissions, utilities, consumer advocate groups, and the like seek to understand and prepare for a market shift to electric vehicles. For example, a few days after filing the continuance request at issue here, the National Association of State Utility

[7] *See* Order No. 9150, PSC Docket No. 17-1094 (Nov. 30, 2017), at 2; Order No. 9183, PSC Docket No. 17-1094 (Feb. 1, 2018), at 2.

Consumer Advocates ("NASUCA"), of which the DPA is a member,[8] adopted the detailed Resolution 2018-02 urging states to consider programs and policies to manage the likely increased demand of electric vehicles for electricity "with the goal of creating a more efficient, reliable, equitable and environmentally responsible electric system." Nat'l Ass'n of State Util. Consumer Advocates Res. 2018-02 (June 24, 2018) (Copy attached at Exhibit C).

11. In fact, the NASUCA Resolution specifically urges utility proposals be supported by "a rigorous analysis of the benefits and costs for the ratepayer." *Id.* at 2. The Gabel Report provides a comprehensive analysis of the Delaware-specific benefits and costs to Delmarva ratepayers and is precisely what NASUCA calls for. Thus, it is surprising DPA is vigorously opposing the consideration of a thorough analysis of Delaware-specific electric vehicle issues, especially when the analysis provides a roadmap to significant savings for Delmarva ratepayers.

12. By way of example, a key finding of the Gabel Report is that managing the anticipated new load thoughtfully and effectively will result in millions of dollars in direct savings for all of Delmarva's ratepayers, not just those who own electric vehicles. Exhibit B, Gabel Report at 4. This is due to the projected market impact on wholesale supply, capacity, and transmission costs, coupled with the dilution

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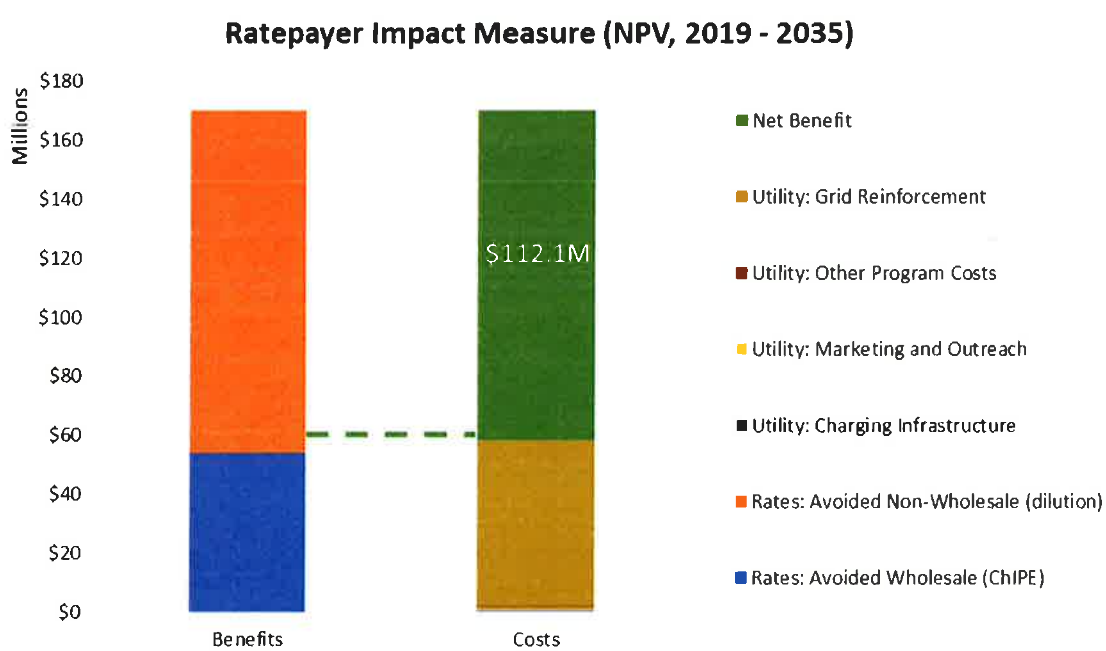
[8] National Association of State Utility Consumer Advocates, Members, http://nasuca.org/members/.

effect of increased electricity consumption on the fixed costs the ratepayers already incur. *Id.* Even when you exclude the benefits and savings from the resulting reduced emissions that everyone will enjoy, Delmarva ratepayers stand to save more than $60 Million per year by 2035, far and above the $2.23 Million program cost being proposed. *Id.*

13. As called for by NASUCA, the Gabel Report provides three different benefit cost projections based on the scope of the defined benefits and costs. Even utilizing the most narrow range of benefits (no externalities considered) and assuming/attributing significant utility grid reinforcement, the "utility investments that are recovered from all ratepayers generate benefits that flow back to all utility customers, with net positive benefit." *Id.* The following diagram compares the costs, benefits, and resulting net benefit results:



Id. at 35. In the end, the Gabel Report's comprehensive analysis of Delaware-specific benefits and costs to Delmarva ratepayers is precisely what NASUCA encourages and what this Commission should consider in the context of this Application. As such, and as the Hearing Examiner recognized, admission of the Gabel Report in this case creates a more complete evidentiary record and is important to resolving this docket.[9] The Commission specifically empowered Hearing Examiner Lawrence to handle scheduling matters and discovery for the purpose of creating a robust record for the Commission to consider. His ruling is entirely consistent with that mandate and should be upheld.

CONCLUSION

For the reasons stated above, Delmarva respectfully requests that the Commission uphold the Findings and Recommendations of the Hearing Examiner dated July 11, 2018.

[9] Hearing Examiner Opinion, *supra* n.2, at 8.

DRINKER BIDDLE & REATH LLP

/s/ Thomas P. McGonigle
Thomas P. McGonigle (ID No. 3162)
222 Delaware Avenue, Suite 1410
Wilmington, DE 19801
Tel: (302) 467-4200
Fax: (302) 467-4201
Thomas.McGonigle@dbr.com

Dated: July 31, 2018

Counsel for Delmarva Power & Light Company

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF DELAWARE

IN THE MATTER OF THE APPLICATION OF DELMARVA POWER & LIGHT COMPANY FOR APPROVAL OF A PROGRAM FOR PLUG IN VEHICLE CHARGING (Filed October 19, 2017)	)))))	PSC DOCKET NO. 17-1094

CERTIFICATE OF SERVICE

I hereby certify that on this 31st day of July, 2018, the within document was filed with the Public Service Commission, via DelaFile and mailed to:

Delaware Public Service Commission
861 Silver Lake Boulevard
Cannon Building, Suite 100
Dover, Delaware 19904

I further certify, on this same date, I served the following persons via electronic mail:

Mark Lawrence, Senior Hearing Examiner	mark.lawrence@state.de.us
Clark M. Stalker, Esquire	clark.stalker@exeloncorp.com
Lindsay B. Orr, Esquire	lindsay.orr@exeloncorp.com
Todd L. Goodman, Esquire	todd.goodman@pepcoholdings.com
Heather Hall	heather.hall@pepcoholdings.com
Kenneth Kristl, Esquire	ktkristl@widener.edu
Robert Willard, Esquire	robert.willard@state.de.us
Josh Berman	josh.berman@sierraclub.org
Connie McDowell	connie.mcdowell@state.de.us
Amy Woodward	amy.woodward@state.de.us
Eric Mease	eric.mease@state.de.us
Kathleen Harris	kathleen.harris@state.de.us
Ralph K. Durstein, III, Esquire	ralph.durstein@state.de.us
David Stevenson	david.stevenson@caesarrodney.org
Andrew Slater	andrew.slater@state.de.us
Ruth Price	ruth.price@state.de.us
Regina A. Iorii, Esquire	regina.iorri@state.de.us

Dated: July 31, 2018

/s/ Thomas P. McGonigle
Thomas P. McGonigle (I.D. No. 3162)
DRINKER BIDDLE & REATH LLP
222 Delaware Avenue, Suite 1410

Wilmington, Delaware 19801
Tel: (302) 467-4200
Fax: (302) 467-4201
Thomas.McGonigle@dbr.com

Exhibit A

DrinkerBiddle&Reath LLP

Thomas P. McGonigle
302-467-4220 Direct
302-467-4201 Fax
Thomas.McGonigle@dbr.com

Law Offices

222 Delaware Avenue
Suite 1410
Wilmington, DE
19801

(302) 467-4200
(302) 467-4201 fax
www.drinkerbiddle.com

CALIFORNIA
DELAWARE
ILLINOIS
NEW JERSEY
NEW YORK
PENNSYLVANIA
TEXAS
WASHINGTON D.C.

Established 1849

June 22, 2018

BY EMAIL & DELAFILE

The Honorable Mark Lawrence
Senior Hearing Examiner
Delaware Public Service Commission
861 Silver Lake Boulevard, Suite 100
Dover, Delaware 19904

Re: PSC Docket 17-1094 – Procedural Schedule

Senior Hearing Examiner Lawrence:

This correspondence is to bring to your attention a development in the above-referenced matter, the result being that Delmarva Power is requesting that we modify the Scheduling Order, including the scheduled Evidentiary Hearing on July 11th and 12th.

By way of background, the issues associated with the widespread adoption of electric vehicles are of significant interest throughout Exelon and other energy companies, not just Delmarva Power. To that end, Exelon engaged a consultant earlier this year to study issues related to electric vehicles in its various jurisdictions. Because we were not aware of the precise scope, its particular relevance to Delaware or the completion date of the study, Delmarva Power proceeded with the schedule in this case without modification. At the time, we concluded that the results of the study would not likely be available in advance of the evidentiary hearing or, if they were, we would simply supplement any applicable discovery responses.

We were recently briefed on the status of this study and have now come to the conclusion it is highly relevant to the consideration of the merits of this matter and that it will provide critical information and analysis that the parties, Your Honor, and ultimately the Commission should consider in the context of this case. The report should be finalized within the next 10-14 days and it will include Delaware-specific analysis and analysis in the context of Delmarva's proposal in this case. It will include cost and societal benefit analyses that are Delaware specific and focused on the potential impact for all Delmarva Power customers if the market for electric vehicles continues to expand and charging is effectively managed.

It seems clear Delmarva Power will have an obligation to provide the report based on some of the discovery requests we have already received. It is also the case that this report will likely inform the testimony of Delmarva's key witnesses, both in terms of the rebuttal testimony they will file and testimony at the evidentiary hearing. Recognizing this creates a fairness issue with respect to the other parties in this matter, we believe it is necessary to allow the parties a full opportunity to review the report, seek additional discovery on issues related thereto, and potentially provide additional testimony around the issues raised in the report, should they deem it appropriate.

To that end, Delmarva Power is requesting that we postpone the evidentiary hearing scheduled for July 11th and 12th and temporarily put on hold all current deadlines until we are able to produce the report and counsel for the parties have had an opportunity to review it. At that time, we will consult with the parties in an effort to reach an agreement on an appropriate scheduling order for Your Honor's consideration.

We apologize for the disruption this request causes and we recognize the timing is not ideal. However, the rapid emergence of electric vehicles and the need to address charging infrastructure needs are critical issues that will have a long-term impact on Delmarva's customers and in the Mid-Atlantic transportation sector generally. While not in agreement on the details, all of the parties in this case share the same interest in wanting the Commission to make the best decisions possible and we are confident that the consultant's report will help in that regard. It is also the case that while this matter should be resolved in a timely manner, there is no immediate urgency that requires an evidentiary hearing in July, as compared to later this fall after the parties have had the benefit of this report and any responses thereto. Indeed, Delmarva Power is aware of no prejudice imposed on any party by its request that we modestly extend the schedule in order to develop a more complete record in this proceeding.

With respect to this request, I have consulted with DAG Willard, counsel for Public Service Commission Staff and DAG Durstein, counsel for the Department of Natural Resources and Environmental Control, both of whom are consulting with their clients. I have attempted to consult with Counsel for the Sierra Club, Kenneth Kristl but we have not connected. I have consulted with David Stevenson, Director for the Center of Energy Competitiveness at the Caesar Rodney Institute, and he is supportive of this request. Finally, I consulted with DAG Iorii and she has indicated the Delaware Public Advocate will likely oppose this request.

Thank you for your consideration of this request and given the compressed timeframe under our current procedural schedule, we will make ourselves available at your convenience.

Very truly yours,

Thomas P. McGonigle
DE I.D. 3162

TPM/dsm

cc: Clark M. Stalker, Esq.
Lindsay B. Orr, Esq.

Exhibit B

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF DELAWARE

IN THE MATTER OF THE APPLICATION OF DELMARVA POWER & LIGHT COMPANY FOR APPROVAL OF A PROGRAM FOR PLUG IN VEHICLE CHARGING (Filed October 19, 2017)	))))	PSC DOCKET NO. 17-1094

FINDINGS AND RECOMMENDATIONS OF THE HEARING EXAMINER

DATED July 11, 2018

Mark Lawrence
Senior Hearing Examiner

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF DELAWARE

IN THE MATTER OF THE APPLICATION OF DELMARVA POWER & LIGHT COMPANY FOR APPROVAL OF A PROGRAM FOR PLUG IN VEHICLE CHARGING (Filed October 19, 2017)	))))	PSC DOCKET NO. 17-1094

Mark Lawrence, having been appointed to act as the Hearing Examiner in this matter by PSC Order No. 9184 dated February 1, 2018, submits the following report to the Commission.

I. APPEARANCES

On behalf of the Applicant Delmarva Power and Light Company ("Delmarva", "DPL" or "the Company"):

By: DRINKER BIDDLE & REATH LLP
THOMAS P. MC GONIGLE, ESQ.

LINDSAY B. ORR, ESQ.
Assistant General Counsel

On behalf of the Public Service Commission Staff ("Staff" or "Commission Staff"):

By: ROBERT WILLARD, ESQ.
DEPUTY ATTORNEY GENERAL

Connie McDowell
Senior Regulatory Policy Administrator

Amy Porter
Public Utilities Analyst III

On behalf of the Delaware Department of Natural Resources & Environmental Control ("DNREC"):

By: RALPH DURSTEIN III, ESQ.
DEPUTY ATTORNEY GENERAL

On behalf of the Division of the Public Advocate ("DPA" or "Public Advocate"):

By: REGINA A. IORII, ESQ.
DEPUTY ATTORNEY GENERAL

ANDREW SLATER
PUBLIC ADVOCATE

On behalf of the Caesar Rodney Institute ("CRI"):

By: DAVID T. STEVENSON, DIRECTOR
CENTER FOR ENERGY COMPETITIVENESS

On behalf of the Sierra Club:

By: JOSHUA BERMAN, ESQ.

KENNETH T. KRISTLE, ESQ.
PROFESSOR OF LAW, DIRECTOR, ENVIRONMENTAL & NATURAL RESOURCES LAW CLINIC, WIDENER UNIVERSITY DELAWARE LAW SCHOOL

BACKGROUND

1. On July 3, 2018, I held a Conference Call for this Docket. The Call centered around Delmarva Power's request on June 22, 2018 to file a new Consultant's Report regarding Electric Vehicle Charging in Delaware. The Report is attached hereto as Exhibit "1."

2. The Report is entitled "Benefit Cost Analysis for Electric Vehicle Adoption in the Delaware DPL Territory." It is was prepared by Gabel Associates, Inc., a New Jersey-based firm of Energy Consultants.

3. If Delmarva Power was permitted to file this Report, the

evidentiary hearings scheduled for July 11 and 12 would have to be delayed, and the Procedural Schedule and Discovery Schedule would have to be amended to afford the other parties a sufficient amount of time to fairly assess the Report and the effect on their respective positions.

4. The Report does not change the programs proposed by Delmarva Power in its Amended Application. Rather, in the Report, Delmarva attempts to give more of a factual basis of why Delmarva believes that the Commission should adopt those programs.

5. The Amended Application seeks the following relief from the Commission: a) that the Commission approve the Company's seven (7) proposed Electric Vehicle Offerings described in the next paragraph; and b) that the Commission establish a regulatory asset to defer costs associated with implementing the proposed Program in the amount of \$2,238,550, although the Company anticipates receiving \$205,000 from program participants leaving a total cost of \$2,233,550 to be borne by ratepayers. Moreover, the Company seeks that: c) the Program's costs categorized as Operations & Maintenance be deferred to a regulatory asset and amortized over a five (5) year period; and d) those costs associated with capital assets be deferred to a regulatory asset and amortized over a fifteen (15) year period, and also be incorporated into rate base and earn a return as part of a base distribution rate proceeding. (Amend App, p.23; Blazunas, pp. 7-9.)

6. In the Amended Application, Delmarva is proposing a voluntary Plug In Vehicle ("PIV") Program, consisting of seven (7) separate, limited offerings for PIV charging in Delaware, described below:

a) **Residential** - with Existing Electric Vehicle Supply Equipment provided by the Company, providing discounted whole House Time of Use encouraging charging during off-peak hours i.e. peak hours are between 12 Noon and 8 p.m., Monday through Friday;[1] these customers will select Level 1 service which is 120-volt, AC power which plugs into a typical electrical outlet; Level 1 service takes about 12 hours to charge a fully depleted 50 mile battery;

b) **Residential** - with Existing Electric Vehicle Supply Equipment, providing a FleetCarma© device option to fifty (50) qualified customers which, if installed in the vehicle, tracks data on usage, location, time and amount of charge; customers installing same will receive a credit on their Level 1 service and an additional credit for off-peak charging;

c) **Residential** - without Existing Electric Vehicle Supply Equipment - the Company will be providing Smart Level 2 Equipment to provide a time of use rate, and if the customers have a range of 30 miles or greater, the Company will install a 2nd Meter at fifty (50) customers' homes at 50% of the cost for a period of at least one (1) year; Level 2 stations are 240-volt, AC power mounted on a wall or a pedestal, and take 3-5 hours to charge a fully depleted battery;

d) **Multi-Family Dwelling Units** (condominium/apartment buildings) with dedicated on-site parking currently without Existing Electric Vehicle Supply Equipment; the Company will provide ten (10) Level 2 stations at 50% of the cost upon request for qualified buildings where at least three (3) Delaware registered PIV owners who are DPL account holders reside, with the building owner paying for installation costs; this offering does not offer discounted whole House Time of Use because multiple residents may need access to the charger and it may be unfair to customers who need to charge during daytime hours;[2]

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1 This is the only one of the first four (4) offerings which does not allow third-party supplier participation. (Stewart, p. 15)

2 For SOS customers selecting a PIV-specific rate under Offerings a through d, they will also have the option of receiving electricity consisting of 100% renewable energy. (Amended App., p. 18)

e) **Public Charging Corridor** - Installation of two (2) Direct Current Fast Chargers ("DCFC") along major roadways in Delmarva's service territory based primarily upon expected use; the Chargers will be Company owned and maintained;

f) **Public Charging Neighborhood Installation** – up to two (2) Level 2 Charging Stations installed in communities in Delmarva's service area "based upon a maximum opportunity for use and convenience of PIV users within the neighborhood;" the Chargers will be Company owned and maintained; and

g) **Electric School Buses** – "Delmarva proposes to work with appropriate agencies within the State of Delaware and/or local schools or community centers to develop a [$370,000] program that will bring the benefits of electric buses … to school aged children within Delmarva Power's service territory." This proposed school bus offering was the primary change between the Company's original and Amended Applications. (Amended App., pp. 14-21; Stewart, pp. 15,20; Blazos, pp. 3-7; Sch. (PBR)-2, p.5.)

7. In its pre-filed testimony, Staff did not disagree with Delmarva's proposed programs but rather sought that the Company's shareholders pay for the program or that the programs are self-sufficient, without ratepayers paying for the programs. (Porter, p.5) Staff has not retained a Consultant.

8. In its pre-filed testimony, the Public Advocate disagrees with the proposed programs and does not want ratepayers paying for the programs. (Slater testimony) The Public Advocate has retained a Consultant. The Public Advocate also argues that funds are available from multiple sources to pay for Delmarva's proposed programs: a) the Volkswagen Settlement funds from the diesel emissions scandal; b) school district requests for electric school buses; and c) state requests. (Slater, pp. 10-11) Intervener

Caesar Rodney Institute ("CRI") also disagrees with Delmarva's proposed programs and does not want Delmarva's ratepayers paying for the programs.

9. Interveners DNREC and the Sierra Club support Delmarva's Amended Application and its proposed programs.

10. Delmarva, DNREC, and the Sierra Club are in favor of Delmarva filing the Report knowing the case will be delayed and additional discovery will take place. Staff, the Public Advocate and CRI oppose Delmarva's request and seek that the evidentiary hearing take place now.

11. I ruled that Delmarva could file the Report, the evidentiary hearings scheduled for July 11 and 12 were cancelled, and a new Procedural Schedule would be implemented allowing necessary new discovery to take place. Since the Public Advocate has advised me that it intended to appeal my ruling, I drafted these Findings and Recommendations.

DISCUSSION

12. According to Rule 2.6.4 of the Commission's Rules of Practice and Procedure: "The Commission, designated Presiding Officer or Hearing Examiner may vary discovery provisions, in the interest of justice …." (emphasis supplied)

13. I have not made any final Recommendations in this case; rather I have simply varied the discovery of the case "in the interest of justice." Respectfully, Staff, the Public Advocate and CRI seek to have the Commission push this case to

hearing now without all of the facts being out of the table, which is not what this Commission has done in the past. Rather, in the past, the Commission has consistently sought to assemble a complete evidentiary record, even if a hearing delay is involved. I dislike a hearing delay as much as anyone. But, I prefer a hearing delay over an obvious incomplete evidentiary record.

14. If the Commission examines the forty nine (49) page Report prepared on Delmarva's behalf attached hereto as Exhibit "1," it will see that it contains detailed analysis which will substantially aid the Commission in deciding this case.

15. The Report gives a detailed analysis as to: the future of electric vehicles in Delaware from 2019 through 2035, the physical and economic impacts on Delaware and its infrastructure, anticipated grid and non-utility costs, and Delmarva's proposed performance on three (3) Net-Benefit Costs Tests: the Adapted Rate Impact Measure (RIM), the Adapted Societal Cost Test (SCT), and the Adapted Total Resource Cost Test (TRC). I believe that this Report is critical for the Commission to properly decide this case in a rapidly changing area of utility law.

16. No party will be prejudiced by the filing of this Report and the delay of the evidentiary hearings. Each party will be afforded a sufficient amount of time to conduct any discovery into the Report which it wants to do. Each party will clear the evidentiary hearing dates with their schedule. Finally, I believe that, based upon the

issues in this case, if the Report is deemed filed, this case can be completed by the end of 2018.

17. Any appeal of these Findings and Recommendations must be taken in accordance with Rule 2.16 of the Commission's Rules of Practice and Procedure.

PROPOSED ORDER

1. Delmarva Power is permitted to file the Gabel & Associates Report effective as of the date of the Commission's Order.

2. The parties and the Hearing Examiner shall work out an Amended Procedural Schedule suitable to all parties which affords each party a sufficient amount of time to conduct discovery as to the Report.

DATED: July 11, 2018

Respectfully submitted,

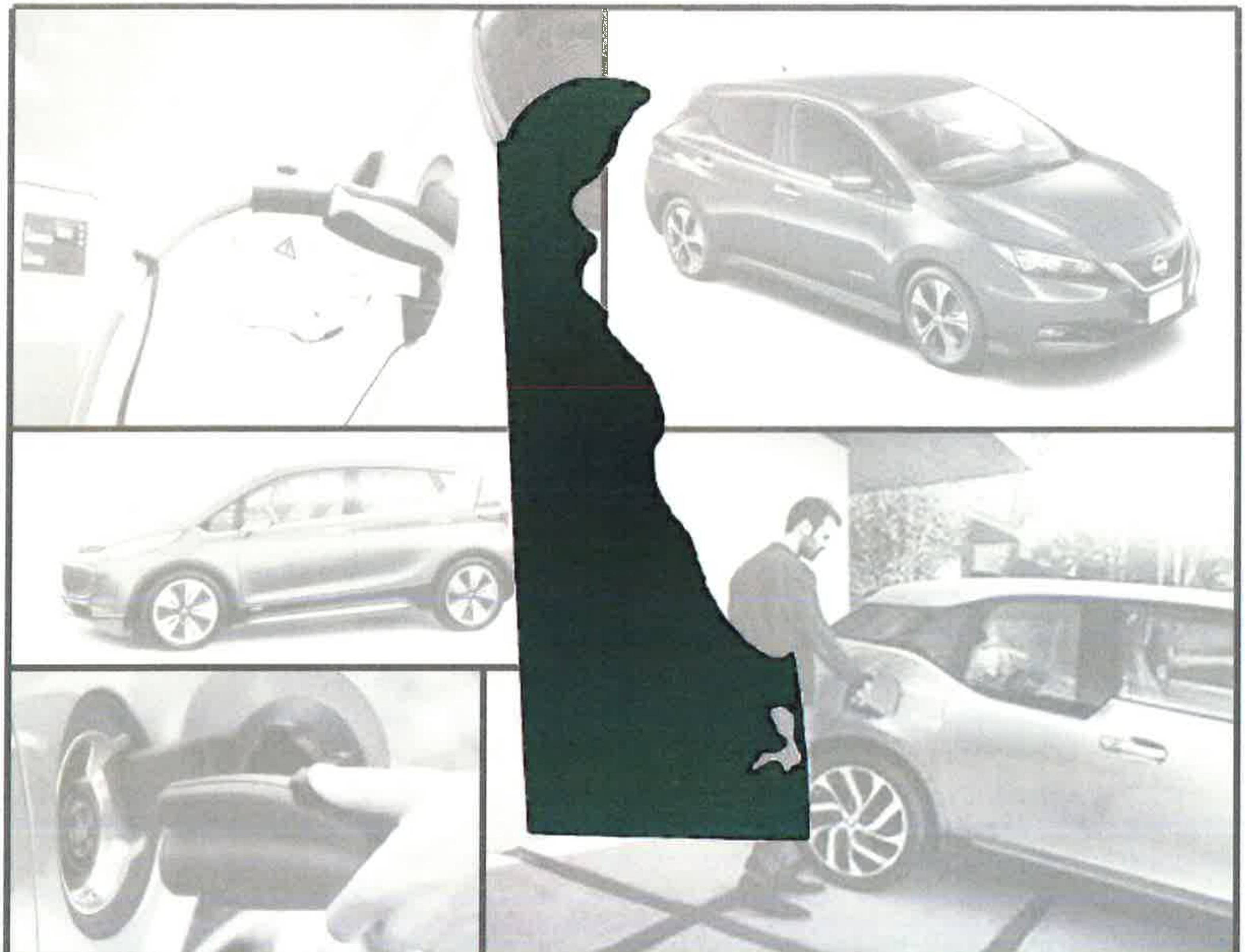
Mark Lawrence

Mark Lawrence
Senior Hearing Examiner

EXHIBIT “1”

delmarva power

An Exelon Company



Benefit Cost Analysis For Electric Vehicle Adoption In The Delaware DPL Territory

Prepared By Gabel Associates, Inc.

July 6, 2018

Acknowledgements

Study and Report Prepared By:

Gabel Associates, Inc.:
417 Denison Street
Highland Park, New Jersey, 08904
732-296-0770
www.gabelassociates.com

Lead Investigator:

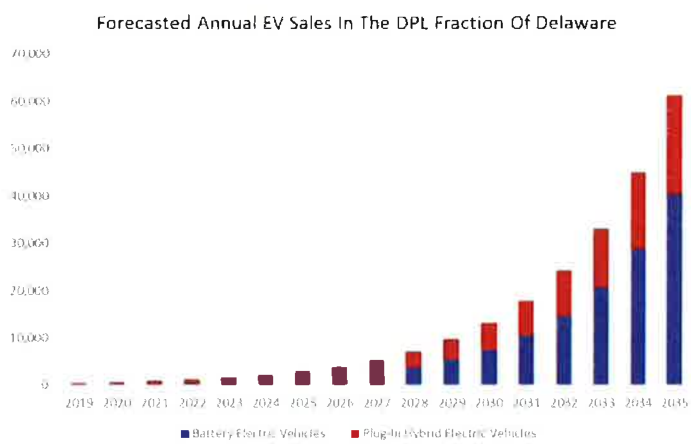
Mark Warner
VP, Gabel Associates, Inc.

Study Team:

Gabel Associates: Steven Gabel, Greg Tyson, Isaac Gabel-Frank, Andrew Conte, Damian Onwuka, Geatali Tampy, Travis Stewart, Holly Reed.

1 Executive Summary

The widespread adoption of Electric Vehicles (EVs) is an emerging trend that is expected to have a profound impact on both personal mobility and electricity markets and infrastructure. As EV use increases, consumers are projected to realize substantial benefits: non-EV owners will benefit from lower electricity costs, and reduced air emissions, while EV owners will realize substantial savings on vehicle operating expense. To both support and enable this opportunity, Delmarva Power and Light (DPL) is proposing a new program for its Delaware territory, with a focus on providing vehicle charging infrastructure, supportive new rate structures, and other innovations. These utility programs provide necessary support for the growing base of EV owners that are now using "electricity as fuel", and will also address known consumer adoption barriers to increase the use of EVs in the DPL-DE territory so that the resulting benefits can be realized by its customers.



This study quantified the projected overall benefits and potential costs of increased EV adoption in the DPL-DE territory, and estimated the NET benefit that will result using three different net benefit tests. The analysis covers the period from 2019 through 2035, and is based on a projection of EV adoption that reflects recent EV sales in Delaware and expected sales rates appropriate for the territory. The projected EV adoption rate achieves approximately 26% penetration of the light duty fleet by 2035. This transition is projected to eliminate the use of 310 million gallons of gasoline, add 2,152.3 GWhrs of electricity consumption, and avoid the emission of 2,076,234 tons of CO_2 over the period. An average Delaware household with one EV is projected to increase its electricity consumption by about 20.4%.

The study is based on detailed simulation of energy market response to EV-induced changes to aggregate load, analysis of DPL tariffs, billing determinants, and revenue requirements, and territory-specific research on travel, consumption, and charging behavior statistics. The resulting specialized model allows for detailed quantification of physical impacts arising from widespread EV adoption, including impacts on electricity use and the environment, while also estimating potential costs to allow for a NET benefit cost analysis over the study period.

In addition to detailed simulation and territory-specific modeling, the analysis considered the specific EV-support program being proposed by DPL for their Delaware customers. The study recognizes two motivations for the proposed utility programs: 1) serving a growing new need by consumers (vehicle charging) in a responsible way, and 2) addressing consumer adoption barriers to encourage higher levels of EV adoption and use. The proposed utility programs create infrastructure which is *needed* to ensure prudent utility accommodation of this new consumer load, and to facilitate realization of the expected benefits in an equitable way. These proposed programs are also *desired*, since they lower consumer adoption barriers, jumpstart increased EV adoption short term, and seed the market for long term growth so as to achieve the widespread EV adoption that benefits for utility customers (and others).

Key conclusions from the benefit analysis (without consideration of cost) include:

- EV-induced benefits are substantial: When considering the broad range of benefits that result from increased EV use, **Delaware residents in the DPL territory will realize a total savings of $996M over the period (nominal sum of recurring annual savings), with an NPV of $478M. This study makes clear that benefits are realized by utility customers that do not drive EVs through lower electricity costs, society at large benefits through cleaner air, and EV owners benefit from reduced vehicle operating expense and federal vehicle purchase incentives.**

- Electricity costs are projected to go down for all utility customers: Electricity rates (including basic wholesale supply, capacity and transmission costs, and utility distribution costs) for ratepayers are projected to go down due to increased EV use. These cost reductions are a result of a) increased overall electricity consumption (which dilutes fixed costs), and b) reductions in wholesale prices due to the fact that most EV charging will be at night during lower-cost off-peak times. **Savings for ratepayers are projected to total $326M over the period (nominal sum of recurring annual savings), with an NPV of $170M.** These savings accrue to utility customers that don't own EVs and EV drivers alike.

- Vehicle operating costs are expected to drop by about half: EV drivers will realize significant savings through reduced operational expense on a recurring annual basis. **In 2019 it will cost approximately 11.95 cents/mile to fuel an average traditional vehicle with gasoline, compared with approximately 6.16 cents/mile for EVs (for both BEVs and PHEVs, blended results) – a reduction of about 48.4%.** Reduced fueling costs, plus lower maintenance costs, are projected to deliver an estimated $1B in vehicle operating expense savings for EV owners (nominal sum of recurring annual savings), with an NPV of $474M through 2035. Widespread EV adoption frees up disposable income for Delaware households, and is expected to pump additional revenue into the local economy rather than importing petroleum products.

- Widespread EV use reduces air emissions, which has economic value in addition to its positive impact on the environment and public health: The study quantifies the NET change in air emissions that result from EV use, considering the reduction in tailpipe emissions net of increased power plant emissions due to increased electricity use. Key greenhouse gases such as CO2 reduce substantially, so that each electrically fueled mile is projected to have 63.8% less CO2 emissions per mile than an average gasoline fueled mile (in 2019). Other key criteria pollutants, especially NOx which has a direct impact on public health, also decline, with a 15.4% reduction projected over the period. There is value in the reduced air emissions that result from fueling with electricity rather than gasoline. **Society will realize a projected $269M in savings through 2035 (nominal sum of recurring annual savings) due to avoided emissions (especially CO2, and NOx), with an NPV of $124M.**

- EV charging will change loading on the grid, potentially to the benefit of all utility customers. By displacing gasoline use with electricity through vehicle charging, there is projected to be a significant increase in electricity consumption over time. Much of this charging will be done in a residential setting overnight. **By 2035, 21.6% of all light duty vehicle miles driven are expected to be "electrically fueled", which for that year will reduce gasoline consumption by 82,369,166 gallons, and increase electricity use 572,058 MWhrs.** Since this is a large load, and since the timing of those loads can be influenced to happen at optimal times (see managed charging below), these changes represent a profound opportunity for load optimization and improved asset utilization (of all types) – both of which reduce electricity costs as noted above.

- Managed charging is a unique opportunity to ensure and maximize EV-induced benefits, but requires active measures to achieve. Most vehicle charging will be done at home, but EV drivers could charge at any time of the day. In a worst case scenario, if all drivers "plug in" as soon as they get home from work, vehicle charging could introduce significant new load at the worst possible peak time, resulting in higher electricity costs for all consumers. There is a natural bias, however, for residential charging to happen overnight, and there is some flexibility in when that charging happens – so long as the vehicle is fully charged in time for use the following morning. While optimal charge scheduling is not a natural consumer behavior, utility sponsored programs can be implemented to encourage optimal charge scheduling – referred to in this document as "managed charging". Managed charging implies conditions where the start of residential charging is deferred until after peak time, *and* vehicle charging is spread out over a full eight hour period over-night. Under scenarios where this type of managed charging is dominant, EV induced load increases during the PJM-coincident peak are expected to be modest: **vehicle charging adds a projected 0.263 MW of load at peak time in 2019, growing to 36.549 MW in 2035. The fact that charging-induced electricity consumption increases significantly, while peak loading increases only slightly, implies a significant increase in the capacity factors for both the generation base and infrastructure (transmission and distribution), and a much flatter aggregate load profile with more consumption in off-peak periods. This outcome is a key driver of the economic benefits outlined above, along with the dilution of fixed costs as detailed further below, and is especially important since it applies to all electricity consumers.** To achieve this outcome, however, managed charging programs must be implemented to encourage optimal consumer charging behaviors. Longer term, managed charging programs could evolve to more sophisticated vehicle to grid (V2G) programs that deliver additional economic advantage by using EV batteries to shave peak load and reduce electricity costs further.

- Benefits induced by widespread EV use outweigh potential costs, and those benefits accrue to all utility customers, society at large, as well as EV owners. Potential costs associated with widespread EV adoption were quantified as part of the study, including the costs of the proposed DPL-DE program for infrastructure deployment, the costs of potential long term grid reinforcement that may be required, and investments made by others as part of EV use, including both vehicle purchase premiums and charging infrastructure investment. These benefits and costs were used to determine a NET benefit using three merit tests, each of which combines benefits and costs differently to provide a range of perspectives on economic merit. The three tests were adapted specifically for EV market characteristics, and include a Rate Impact Measure (RIM), the Societal Cost Test (SCT) and the Total Resource Cost (TRC). All three merit tests demonstrate strong NET benefit, including both benefit/cost ratios greater than 1.0, and NET benefits (after considering costs) that are positive. A summary of key benefits, costs and NET impact are provided in the chart below[a].

[a] The benefits noted in this chart include the recurring annual savings for utility customers (through lower electricity costs), EV drivers (through lower operating expense), and society at large (based on the value of lower emissions), combined with the one-time benefits realized by EV owners through the federal vehicle purchase tax incentive.

Benefit/Cost Summary			
Total Benefits (NPV, 2019-2035):	$827,034,789		
Total Costs (NPV, 2019-2035)	$312,943,596		
	RIM	SCT	TRC
Benefit To Cost Ratio (based on NPV):	2.92	2.64	2.25
Net Benefit (benefit minus costs, NPV):	$112,058,830	$514,091,193	$390,544,344

The RIM test specifically considers benefits for all utility customers through lower electricity costs resulting from EV adoption as balanced by recovery of utility investments through rates. The positive RIM test results demonstrate that utility customers, even those that don't drive an EV themselves, realize savings from lower electricity costs that exceed investments being recovered by the utility.

In Conclusion: the study quantified benefits that apply across a broad range of populations, along with associated potential costs, so that NET benefit merit tests could be conducted. The detailed projections developed in the study demonstrate that benefits exceed costs, and that there is NET benefit across multiple stakeholder groups which justifies the utility programs being proposed. These benefits result from a broad portfolio of impacts including lower electricity costs for all utility customers, increased disposable income for Delaware households due to lower vehicle operating costs, and the multiple benefits of reduced air emissions. The adapted TRC and SCT tests demonstrate that society at large, and particularly residents within the territory, are better off as a result of widespread EV adoption even after considering a broad range of costs. More specifically, the RIM test demonstrates that utility customers realize lower electricity costs that offset proposed and potential investments that would be recovered by the utility through rates. These results demonstrate that the proposed utility programs directly benefit DPL-DE customers (in addition to EV owners), and that the public interests are well served by approval and implementation of the proposed programs.

2 Introduction

The widespread adoption of Electric Vehicles (EVs) is an emerging trend that is expected to have a profound impact on both personal mobility and electricity infrastructure. As EV use increases, a wide range of beneficial impacts are anticipated, including lower electricity costs, reduced air emissions, and substantial savings for EV owners. In response to this opportunity, Delaware Power and Light (DPL) is proposing a new program for its Delaware territory, with a focus on providing vehicle charging infrastructure, supportive new rate structures, and other innovations. These utility programs provide necessary support for the growing base of EV owners that are now using "electricity as fuel", and will also address known consumer adoption barriers to increase the use of EVs in the DPL-DE territory.

Exelon/PHI, DPL's parent, commissioned an in-depth study of the projected impacts of increased EV adoption, identification of specific benefits for a range of populations, and associated costs. The resulting benefit-cost analysis quantifies the NET benefit that results from widespread EV adoption in the DPL-DE territory, including consideration of the costs associated with the proposed utility program to support and encourage that level of EV use (among other factors). The study was conducted by Gabel Associates (Gabel), a consulting firm with well-established expertise in energy, environmental, utility, and policy research. The benefit-cost analysis builds on experience gained conducting similar studies in other jurisdictions.

This document summarizes the benefit-cost analysis, including methodology review, quantification of the benefits expected to result from the program, an inventory of potential costs, and formal net benefit-cost test results.

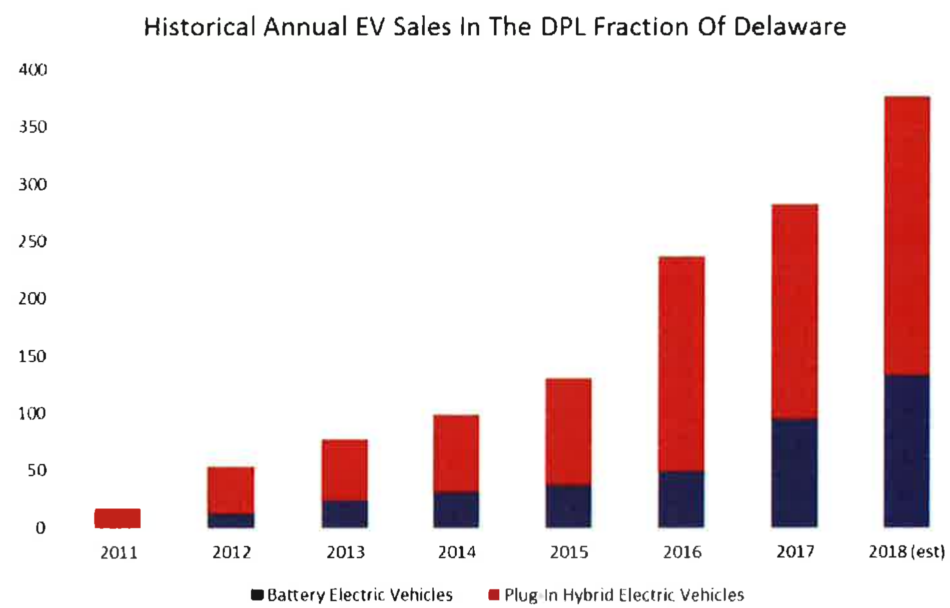
3 Electric Vehicle Adoption Forecast

The study is based on a forecast of EV adoption within the DPL-DE territory from 2019 through 2035. The forecast is based on historical EV sales in the territory[1], extrapolated over the period based on annual sales growth rates consistent with projected market conditions for the territory. The extrapolation accounts growth of the EV fleet through new sales, as well as vehicle retirements[2]. This forecast is the basis for all the impact and benefit analysis, and allows consideration of overall EV adoption impact, not just the impact of the utility program as a stand-alone entity. This approach is appropriate since the proposed utility program is impacting the market simultaneous with other developments that serve to increase EV adoption (lower vehicle costs, increasing vehicle configuration options, growing consumer awareness, etc.). The proposed utility programs are considered an important part of these market growth assumptions, however, since they directly impact key consumer adoption barriers (home charging infrastructure, especially in the challenging multi-family segment, increased public charging availability, improved consumer awareness, etc.)[b]. The proposed utility programs are necessary to respond to a new consumer need (vehicle charging), but also jumpstart EV adoption short term by lowering barriers, seeding the market for long term growth to ensure optimal and equitable realization of benefits across multiple populations.

[b] The proposed utility programs lower adoption barriers, in addition to establishing an important foundation in managed charging.

The forecast (and subsequent analysis) focuses on light duty vehicles (cars, and light passenger trucks such as SUVs) being displaced by "Electric Vehicles", including both pure battery electric vehicles (BEVs), and plug-in hybrid electric vehicles (PHEVs). Both vehicle classes "have a plug", and are able to store electricity in a battery or similar device from a source external to the vehicle. Vehicles "without a plug", such as traditional NON-plug-in hybrids, are not included. The analysis focuses exclusively on light duty vehicles, and does not consider medium or heavy duty vehicle electrification that may be occurring simultaneously.

The following chart summarizes recent EV sales within the DPL-DE region:

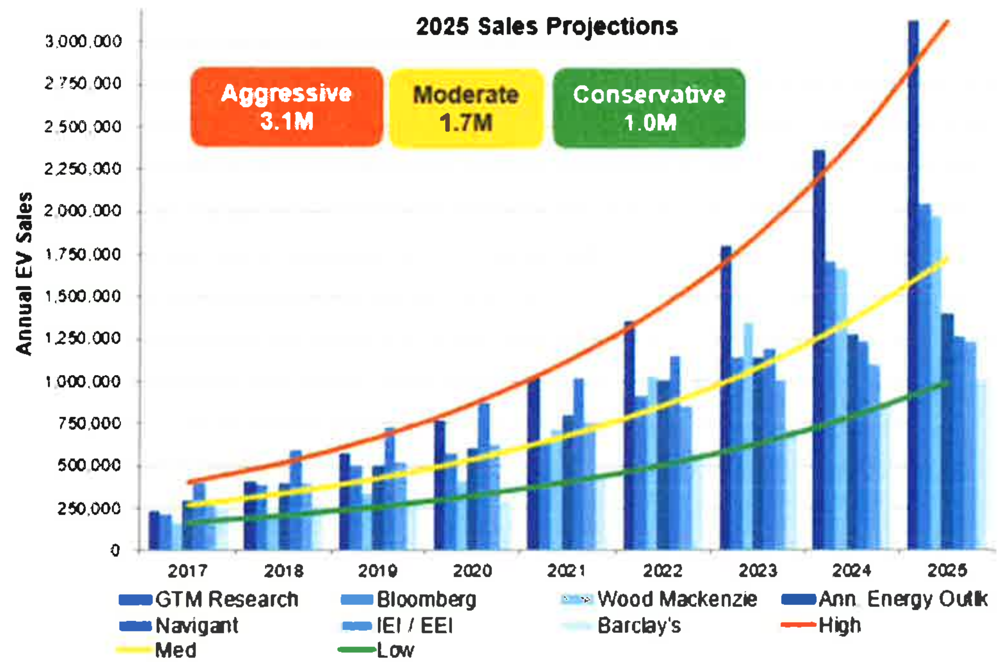


The forecast is based on the EV fleet size in 2018 projected at a 40% growth rate for BEVs, and a 30% growth rate for PHEVs, resulting in a blended growth rate of 34.9%[3]. These growth rates were selected based on consideration of a variety of market growth factors specific to the DPL fraction of the Delaware market:

- EV penetration on a per capita basis in Delaware has been significantly below the national average to date: there are 1.32 EVs per 1,000 residents in Delaware as of the end of 2017, compared with a ratio of 2.21 nationwide, and 8.9 for the leading state California. Leading ZEV states are typically in the range of 2.0 to 3.8 EVs per 1,000 people (as of the end of 2017).

- Despite that relatively small starting base, sales have strengthened recently. Delaware annual sales growth averaged 50.6% over the last two years. For reference, national EV sales demonstrated year/year growth of 36.6% in 2016, 25.9% in 2017, and 35.5% YTD 2018 (through April). These rates are the AVERAGE nationwide, with leading states demonstrating significantly higher growth.

- A wide variety of consulting and market studies have projected EV adoption long term, with estimates generally becoming much more bullish as the market matures. The following chart summarizes the range of projections, which reflect concurrence for "moderate" growth levels being approximately 25%.



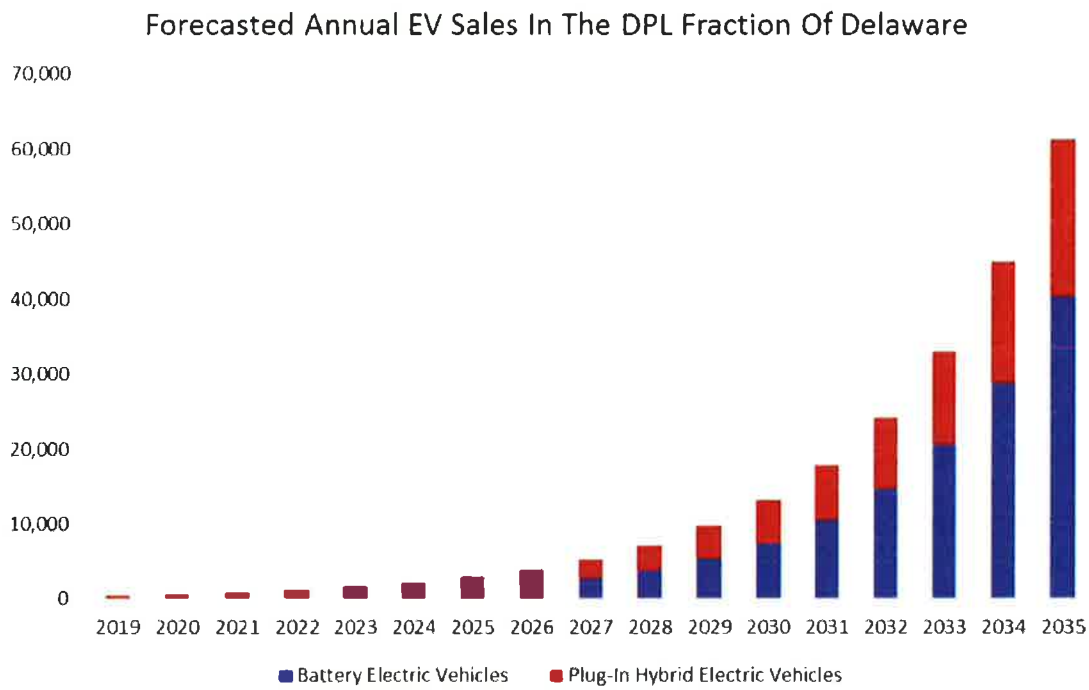
Based on analysis by Atlantic City Electric. Sources embedded in chart.

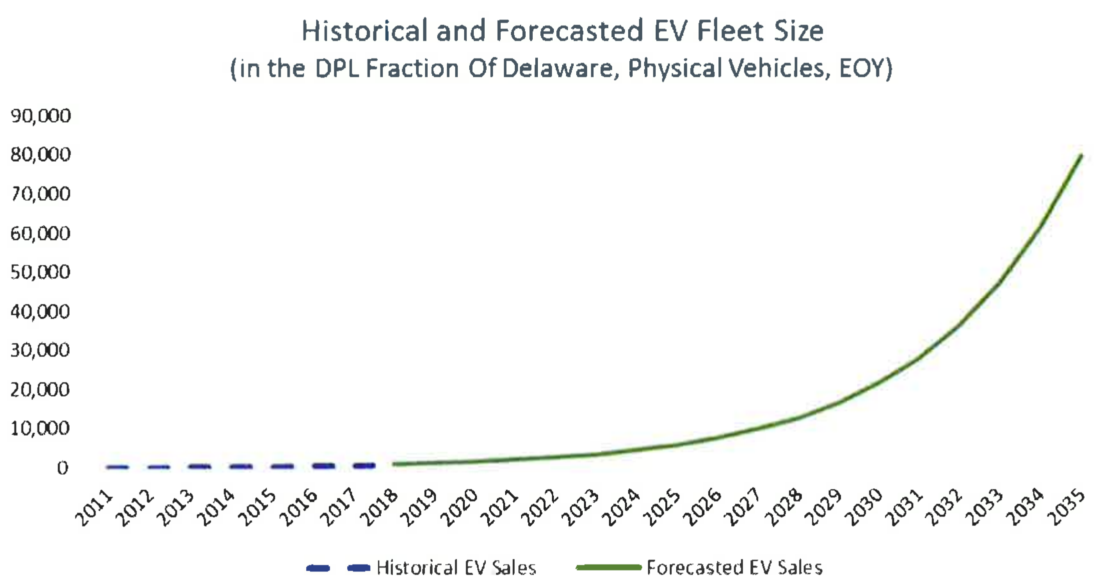
- Average median household income in Delaware is slightly above the national average ($61,017 averaged 2012-2016, compared with ~$57,00 for the U.S. overall (2016), U.S. Census Bureau), which is a positive indicator for strong EV sales. Other demographic factors are particularly strong for EV adoption: a) 92.7% of households have at least one vehicle[4], b) only 17.6% of homes are multi-family, and 70.9% of homes are owner occupied[5], and c) per-capita vehicle ownership is relatively high: 1.2 vehicles per person in 2015[6].

- Delaware has introduced incentives for both vehicle purchase and charging infrastructure, which have likely contributed to the recent increase in EV sales. If continued, and especially with the proposed utility program to provide additional incentives and reduction of market barriers, the recent strong annual sales rate are projected to be sustainable long term.

- Given this combination of factors, and assuming continuation of existing incentives and implementation of utility programs that lower adoption barriers, annual sales growth in Delaware is projected to remain above the national average. That results in the state starting with a relatively small base, but with strong growth long term (especially after 2025). These factors support the estimated growth rates of 40% for BEVs and 30% for PHEVs (34.9% blended rate).

The following charts summarize the forecasted EV sales for the DPL-DE territory and the resulting EV fleet size over the analysis period (after accounting for vehicle retirements)[c].





[c] If BEVs are a larger fraction of the vehicle mix, many of the benefits quantified in the following section will be slightly higher through elimination of occasional gasoline use by PHEVs.

4 Methodology For Measuring Impacts

Many of the impacts from EV use result from how vehicle charging impacts both electricity markets and utility infrastructure. These impacts have physical, economic, and environmental dimensions that can be quantified, in addition to broader strategic implications. The benefit-cost analysis is therefore based primarily on quantifying the net impact of displacing gasoline consumption with electricity use. The analysis is based on the following scope, methods, and assumptions:

1. **Analysis Period:** The study computes annual impacts for the years from 2019 to 2035.

2. **Territory**: The analysis is based on a forecast of EV adoption within the DPL-DE territory over the analysis period, building on a) historical sales of EVs in the territory, and b) expected sales growth as already evident, as reinforced by a variety of positive market developments that are expected to encourage EV adoption growth, including the utility programs being proposed. Section 3 provides details on the EV forecast that is the foundation of the study.

3. **Delaware Market Conditions:** The EV forecast is translated into a variety of statistical models that quantify vehicle use and energy impacts. These models are based on market research for the DPL-DE territory, and reflect customer behaviors and market conditions specific to that territory, including vehicle characteristics (energy efficiency), travel patterns (average miles per day, etc.), charging schedules (where EV drivers charge, and when), baseline electricity consumption patterns, cost factors, etc. *This EV impact study is therefore based on modeling details that are tuned to the DPL-DE territory to the greatest extent possible.* In cases where territory-specific data was not available, regional or national statistics were used.

4. **Charge Schedule:** The impact that EV charging has on electricity markets and utility infrastructure, with the associated physical, environmental, and economic benefits (as detailed in the sections below), depends heavily on WHEN the charging occurs. The analysis assumes "managed charging" schedules, since the utility programs are intended to encourage vehicle charging at optimal times. The loading profile for vehicle charging is based on a detailed market model with six segments (private residential, multi-family residential, workplace, fleet, public corridor charging, and public community charging) and time-of-day usage profiles provided by industry and various studies regarding vehicle charge scheduling. The Managed Charging profile assumes that most residential charging responds to programs intended to encourage optimal charge scheduling, including a) deferral of the start of charge until after peak hours, and b) spreading vehicle charging loads out over an 8-hr period overnight. The utility program being proposed provides for an early implementation of programs to encourage optimal charge scheduling, a mix of solutions to allow learning about which offers work best with consumers, and establishes a foundation for more advanced managed charging programs medium term.

5. **Impact Modeling:** These input statistics are combined in a specialized model that quantifies physical and economic impacts, as described more completely in Section 5:

    a. Physical impacts include gasoline displacement, changes in energy use (MWhrs, PJM-coincident peak), implications for PJM generation requirements, and NET changes in emissions of CO_2, NOx, and SO2. These emission changes account for the NET impact of reduced tailpipe emissions and increased emissions associated with electricity generation induced by vehicle charging. Power plant emissions are determined through the PJM dispatch simulation described below, which aggregates the projected emissions, asset by asset, hour-by-hour, over the year as required to meet the load[d]. *This analysis is therefore based on very granular simulation of actual plant dispatch with known emission rates, rather than using more general gross emission factors.*

    b. Economic impacts are examined from three perspectives: changes in electricity costs as seen by all ratepayers, reduced operating expenses for EV owners, and the societal value associated with reduced emissions, as described in more detail below.

6. **Electricity Costs:** Determining how EV charging affects electricity costs is a primary focus for the study, and is achieved through a comprehensive model that examines wholesale market impacts, implications for capacity and transmission costs, and impacts on the distribution revenues collected by the utility. Both aggregate (total $, and total MWHR) and unit-cost impacts are quantified, which allows for determination of electricity cost changes that affect all ratepayers.

    a. **Wholesale Cost Impacts**[e]: EV charging, especially if done during off-peak times, changes the shape of the aggregate load curve. This modified load curve results in a change in the average wholesale cost of electricity since more electricity is purchased during lower cost, off-peak times[f]. Gabel forecasts these impacts based on a detailed asset dispatch simulation using AURORAxmp (AURORA). AURORA is an

[d] The simulation mostly assumes business as usual for asset dispatch. Increased use of cleaner sources, especially class I renewables, could make the benefit impacts quantified in this study even stronger. Note that the utility program proposal includes use of renewable energy for supply on some program elements, which is more advantageous than the "business as usual" assumptions conservatively used in the study.

[e] For the purposes of this analysis, "wholesale costs" reflect the raw "factory gate" price for generating electricity considering capacity factors, fuel sources and costs, marginal pricing, etc. Other costs that are also part of the wholesale market, including PJM ancillary charges, capacity costs, RPS costs, etc, are captured as part of the other electricity cost elements (either capacity and transmission, or bundled as part of the utility distribution costs). This structure is used because changes in average pricing affect only the raw generation costs, not necessarily other PJM costs in a similar way, and this approach ensures the most conservative, fair, and transparent impact assessment.

[f] EV charging creates a Charging Induced Pricing Effect (ChIPE) that is similar to the Demand Response Induced Price Effect (DRIPE) factor recognized for energy efficiency/demand response programs, although the market impact dynamic is very different. Optimal vehicle charging "fills the trough" in the aggregate off-peak load profile resulting in ChIPE, while demand reduction programs "shave the peak" to create DRIPE. The affects are similar, however in that the modified load curve changes the overall average cost of wholesale electricity.

industry-leading software and data package that simulates the hourly commitment and dispatch of electric generators to serve load, recognizing utility-level peak demand, transmission constraints, operational characteristics of generators, delivered fuel prices, emissions prices, etc. Gabel completed hour-by-hour market simulations using AURORA, for every year from 2018 - 2035. Total electricity costs ($ per year), average wholesale unit costs ($/kwhr)[g], and generation emissions (tons) are the primary outputs of the simulation. *Unlike other EV impact studies that depend on gross emission and cost-change factors, this study makes use of detailed market dispatch simulations specific to the EV adoption forecast and market conditions in the DPL-DE territory and PJM.*

b. **Capacity and Transmission Costs**: The dispatch simulation noted above computes the PJM-coincident peak for each year. Costs related to the charging-induced capacity (with reserve) and transmission requirements are computed based on forecasted cost factors for PJM capacity and transmission. See Appendix A for more details on capacity and transmission cost calculations.

c. **Utility Distribution Costs**: A detailed analysis of current DPL tariffs for the DE territory was completed, as well as analysis of significant information provided by the utility regarding distribution-costs and revenue requirements (see Appendix A for more details). The resulting distribution costs were projected forward using both utility and Energy Information Administration (EIA) statistics on distribution revenue growth to establish the utility distribution costs.

d. **Total Electricity Cost Impacts:** The PJM dispatch simulation and revenue requirement analysis summarized above allows the wholesale, capacity, transmission, and distribution costs for a given load profile to be determined for each year of the study period. This analysis is completed for both the baseline case without EVs, and the load profile under consideration including EV charging. Both the gross electricity costs (annual $) and the average unit cost ($/kwhr) are determined. The difference between the EV scenario and the baseline represents the impact on overall electricity costs. Overall electricity use (total MWhrs) goes up due to the increased electricity use associated with vehicle charging, but unit costs ($/kwhr) go down due to the combination of reductions in average wholesale unit costs due to more optimal loading, and dilution of distribution costs through increased MWhr volume. The combined economic impact of these considerations are summarized in Section 5.2.4.

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[g] This average unit-cost represents a load-weighted average across all times and locations, and is really a gross indicator for wholesale electricity costs. In a competitive market like PJM, those costs efficiencies are expected to eventually flow through to customers. How those savings are allocated to a particular customer class or tariff depends on wholesale market response and future utility rate case decisions, and so individual customer impact may vary by class or tariff.

7. **EV Operating Costs:** It costs less to "fuel" an EV with electricity than it does to fuel a traditional vehicle with gasoline. Furthermore, early market evidence suggests that EVs cost less to maintain due to the simplified drive train. These two factors combine to generate significant savings for EV owner/operators[h]. The fuel savings are computed based on a projection of electricity and gasoline prices, while maintenance savings are estimated based on results from an independent vehicle operating cost study on a per-mile basis. To ensure a fair comparison, an additional expense is assumed for EV owners based on replenishment of the infrastructure funding lost through avoided state and federal gasoline taxes. See Appendix A for more details on EV operating cost analysis.

8. **The Value Of Avoided Emissions**: Current levels of vehicle emissions impose significant costs on society through health care expenses, extreme weather damage, lost worker and business productivity, asset devaluation, etc. Although frequently considered an "externality", there is real economic value that accrues to society due to the avoided emissions enabled by widespread EV adoption. The study calculates the value of this avoided emissions (for CO_2, NO_x, and SO_2) based on social cost studies from independent sources on a per-ton basis. See Appendix A for more details on the economic calculations related to avoided emissions.

9. **Program Costs:** The utility is proposing a program that delivers equipment and services to participating customers to better support the needs associated with EV adoption, and to help address adoption barriers that will help expand and accelerate EV use. These programs represent direct investment and expense. In addition, as EV use grows and utility infrastructure is required to deliver the additional electricity required for vehicle charging, additional investments in grid reinforcement may be required. Lastly, EV adoption imposes additional costs on non-utility participants, such as the premium associated with vehicle purchase, or investments in charging infrastructure being made by private (non-utility) entities. The study estimated the costs associated with all three areas to create a more complete profile of potential costs, which are detailed in Section 6. See Appendix A for more information about how costs were estimated.

10. **Formal Net Benefit Tests:** The net economic benefits from forecasted EV adoption are summarized in Section 5.2, and potential costs are summarized in Section 6. These benefits and costs can be combined to provide a NET benefit, after accounting for costs. There is no formal consensus on how to calculate net benefits related to proposed EV programs, but there are well established methods for evaluating the merit of energy efficiency (EE) programs. These EE tests need to be modified to account for conditions specific to EV adoption, but once properly adapted, they can be used to quantify the policy merit for proposed EV programs. Based on a review of methods used by others and synthesis of associated best practice, three adapted tests have been developed for this study: a Ratepayer Impact Measure (RIM), the Societal Cost Test (SCT), and the Total Resource Cost

[h] The benefit analysis quantifies the operating expense savings realized by EV owners. Full characterization of economic benefit must also consider potential vehicle purchase premiums, as well as other incentives that might apply to offset vehicle purchase price. These factors are incorporated in the NET benefit tests outlined in Section 7.

(TRC) test. These different tests characterize how different impacted populations experience net benefits, and taken together provide a well-rounded view on overall merit. The formal NET benefit tests are described in Section 7.

11. Additional details about scope, assumptions, and methodology can be found in Appendix A.

5 KEY RESULTS: The Impacts Of EV Adoption

EV adoption delivers an unusually broad range of impacts, across a range of populations and market segments. The study quantified these impacts as a function of EV adoption over time, including both aggregate physical impacts, and a variety of economic benefits.

5.1 Key Results: Physical Impacts

Fueling light duty vehicles with electricity rather than gasoline creates a profound change in fuel usage, electricity usage, and changes in the associated emissions. Based on the EV adoption forecast in Section 4, combined with travel statistics for Delaware and average vehicle performance characteristics, the study identified a variety of physical impacts, including:

- EVs are forecast to account for 0.8% of new vehicle sales in 2019, growing, to 81.2% by 2035.

- EVs account for 0.3% of the light duty fleet overall in 2019, but are projected to grow such that EVs account for 26.4% of light duty vehicles on the road by 2035.

- As EV penetration grows, an increasing fraction of miles driven will be powered by electricity rather than gasoline. By 2035, 21.6% of all light duty vehicle miles driven are expected to be "electrically fueled". This increasing electrification displaces significant gasoline use – in 2035, EVs are projected to avoid consumption of 82,369,166 gallons of gasoline, and a total of 310,183,181 gallons of gasoline will be displaced over the period from 2018 – 2035.

- In 2019, EVs are projected to consume an average of 2,534 kwhrs of electricity per vehicle annually for battery charging[i], or an average 6.94 kwhrs per day. Those consumption factors are expected to increase slightly through 2035, but at a slower pace past 2025 as larger and heavier EVs come onto the market. **For a household with one EV, vehicle charging will account for an average of 20.4% of the electricity consumption for that household over the period.**

- At an aggregate level, EVs are projected to require 3,818 MWhrs of electricity for vehicle charging in 2019 (across all charging segments), growing with EV population to 572,058 MWhrs by 2035.

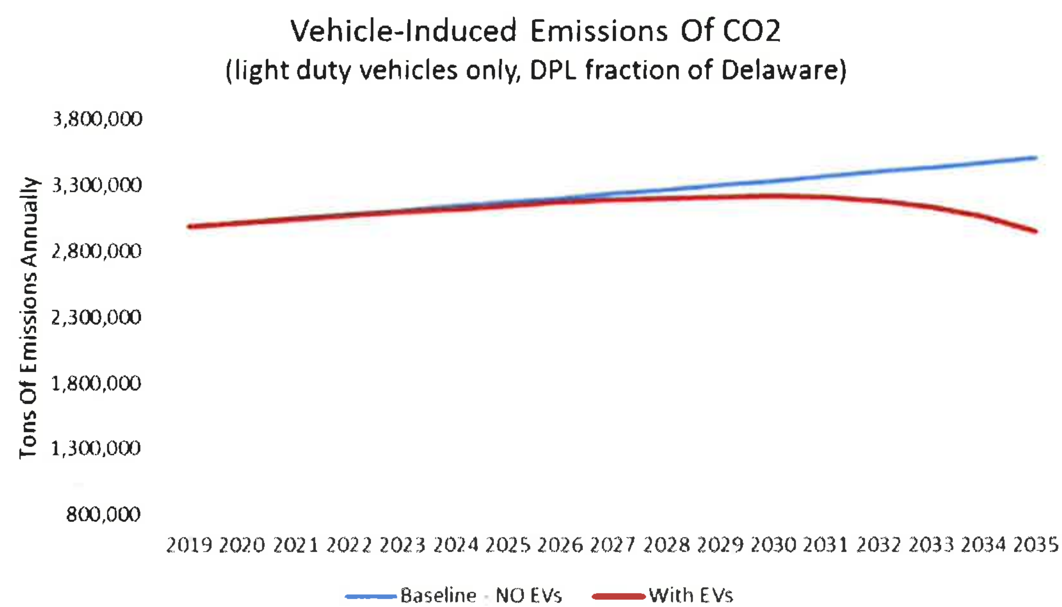
- When "managed charging" is dominant, most charging (on a kwhr basis) is residential and during off-peak periods at night. In that case, EV induced load increases during the PJM-coincident peak are expected to be modest. Vehicle charging adds a projected 0.263 MW of load at peak time in 2019, growing to 36.549 MW in 2035. The fact that charging-induced electricity consumption increases significantly, while peak loading increases only slightly, implies a significant increase in the overall generation base and infrastructure capacity factors (i.e. utilization), and a much flatter load profile overall with more consumption in off-peak periods. This outcome is a primary driver of the economic benefits summarized in Section 5.2.1.

- By fueling with electricity rather than gasoline, emissions at the tailpipe are eliminated, but emissions at the power plant go up. For most pollutants, vehicle emissions reduce much more

[i] This represents a blended average consumption-per-charge for BEVs and PHEVs.

than power plant emissions increase, resulting in a NET reduction overall. **In 2019, each electrically fueled mile is projected to be 63.8% cleaner (for CO_2) than an average gasoline fueled mile.** This "clean-up factor" increases slightly over time as the grid becomes cleaner[j], so that by 2035 EVs could be 70.7% cleaner (for CO_2) than average gasoline vehicles.

- Carbon Dioxide (CO_2) is a primary GHG, and burning gasoline in vehicles accounts for the largest share of CO_2 emissions in the state[7]. As EV penetration grows, NET CO_2 emissions decline significantly. T**ransportation induced CO_2 emissions (light duty vehicles only) are projected to reach 3,507,067 tons by 2035 in the baseline case WITHOUT EVs, but would reduce to 2,948,523 tons by under the forecasted EV adoption scenario – a 15.9% reduction. Over the period, a projected 2,076,234 tons of CO_2 are avoided, or 9.01 tons of CO_2 avoided per EV sold.** Note this reduction results from EV penetration of 26.4% in 2035, and CO_2 reductions continue to grow in lockstep with increased EV adoption. The following chart summarizes the reduction in CO_2 emissions resulting from the forecasted rates of EV adoption compared to baseline usage without EVs:



- Nitrogen Oxides (NOx), which are a criteria pollutant that directly affects public health and are also a pre-curser to other forms of air pollution, also declines with increased EV adoption. **NOx declines from a projected 2,121 tons for the no-EV baseline case in 2035, to 1,790 tons instead, a reduction of 15.4%.** The following chart illustrates the decline in NOx emissions resulting from growth in the use of EVs.

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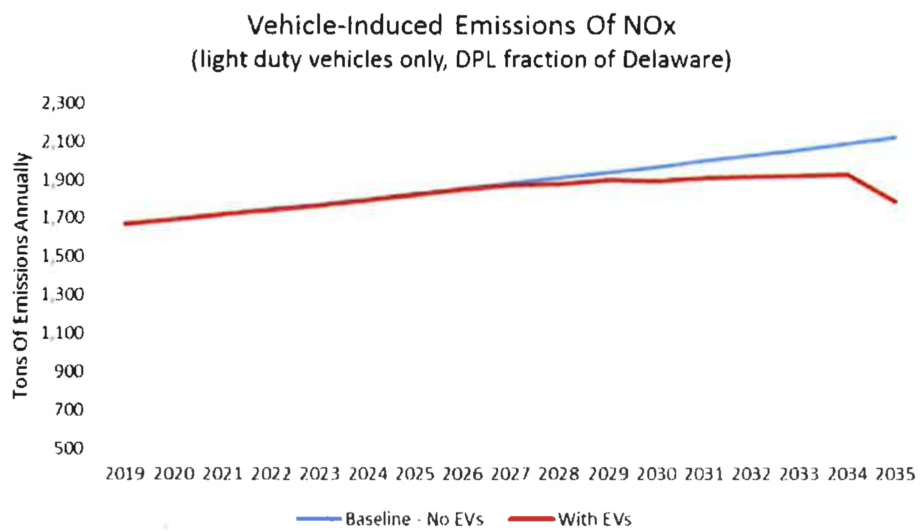
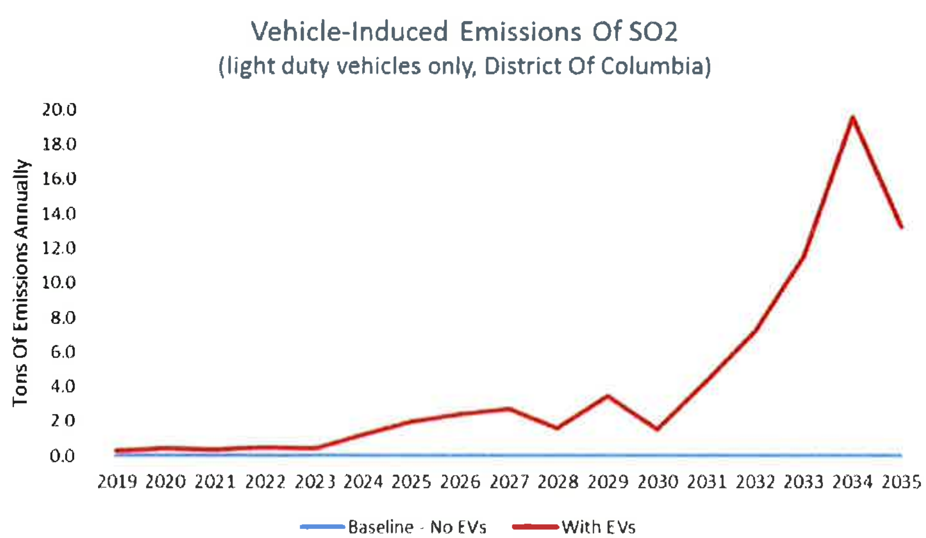
[j] The simulation model assumes "business as usual" for existing generation assets and deployment of any new capacity required. Given the significant displacement of coal generation by natural gas already underway, emission factors of the generation base continue to reduce. Those reductions could be faster and larger, however, with increased use of carbon-free renewable energy. There is a significant synergy between EV adoption and increased grid de-carbonization. Note that the DPL-DE EV proposal will offer a 100% clean energy supply option for EV charging, which could make the "clean up" factor quantified in aggregate through this study stronger.



- Sulfur Dioxide (SO_2) is a criteria pollutant that harms human health directly, contributes to the creation of "acid rain", and is a precursor to other air pollutants, especially particulates. SO_2 emissions *increase* with EV use – although only slightly. Light duty vehicles emit essentially no SO_2, but power plants do – especially in cases where coal is used heavily. As a result, the "zero emissions" of SO_2 by gasoline fueled vehicles is replaced by modest SO_2 emissions at the power plant. While this is a negative outcome, the difference in scale associated with SO_2 emissions should be noted: while CO_2 emissions are measured in millions of tons, SO_2 emissions increase by an estimated 19.6 tons at the highest point over the period. More importantly, the emissions rate for SO_2 continues to decline for electricity generation as the grid migrates to cleaner sources, especially solar and wind. The negative SO_2 implications short term will likely soften longer term due to beneficial changes in supply mix.



5.2 Key Results: Economic Impacts

Increased EV use is expected to deliver significant economic benefits for a variety of impacted populations, and these benefits scale strongly with aggregate EV adoption level. As summarized in Section 4, the study quantified beneficial impacts through reduced electricity costs (for all ratepayers), reduced vehicle operating costs (for EV owner/operators), and value from avoided emissions (for society at large). The following sections summarize the economic benefits associated with the EV adoption forecast in Section 3, compared with baseline conditions for the DPL-DE territory.

5.2.1 Avoided Electricity Costs

EV charging increases overall electricity consumption, and shifts the aggregate load profile to include a larger fraction of energy in lower-cost (off-peak) times, especially under the influence of utility "managed charging" programs that help influence vehicle charging schedules. As a result, overall capacity factor for both generation assets and the distribution system increases, and the load curve that affects energy pricing is more optimal. Together, these efficiencies result in a reduced cost of electricity that benefits all utility ratepayers, not just EV drivers. The study quantified these impacts through the methodology outlined in Section 3, resulting in the benefits summarized below:

- **Ratepayers will realize savings through lower electricity costs, scaling upward with increased EV use, with projected savings exceeding $61.6M a year in 2035.** Those savings represent only non-EV-charging usage[k], and are projected to total over $325.7M over the period (nominal sum of recurring annual benefits), with an NPV of $170.3M[l].

- Electricity costs (on a unit cost, $/kwhr basis) are expected to be 4.5% lower in 2035 than they would otherwise be as a result of the forecasted EV use. Cost improvements continue to accrue as EV adoption grows.

- Those savings reflect a combination of lower average wholesale costs, and dilution of all other costs (especially distribution costs) over larger electricity volume as summarized in the Methodology section (see Appendix A for more details on the energy cost impact calculations). Those impacts vary in proportion over time, with dilution effects

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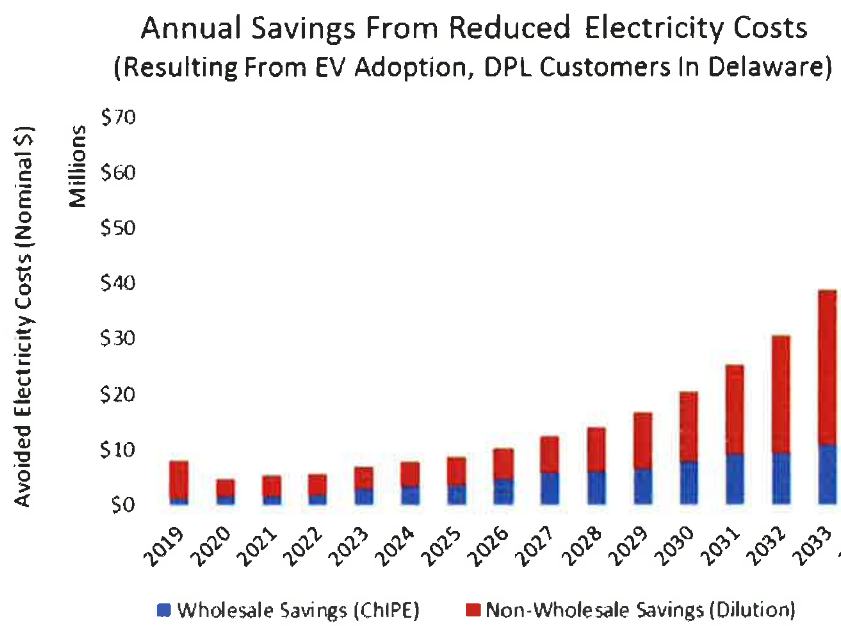
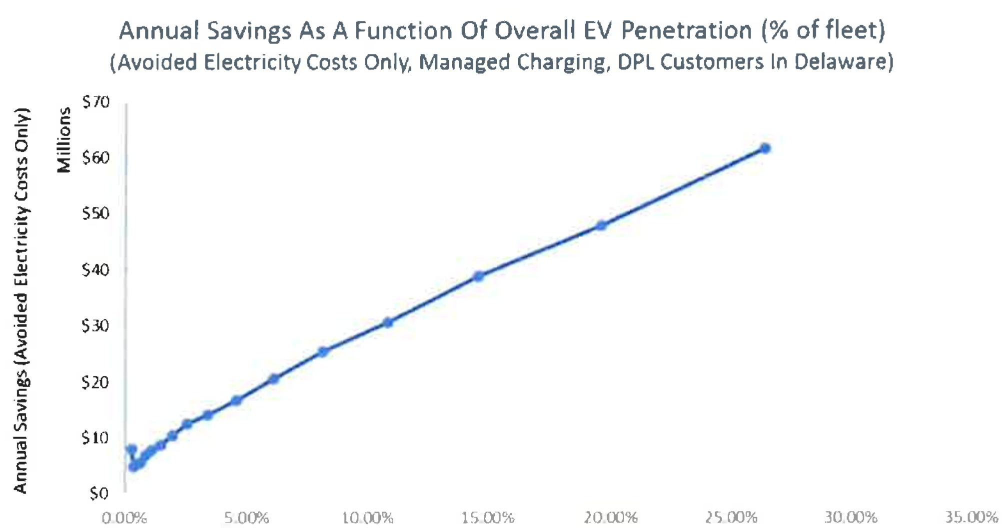
[k] The "rate payer" savings noted reflect the projected lower unit costs ($/kwhr) applied against ONLY non-EV charging loads, which makes that benefit applicable to non-EV owners. EV owners will also realize the benefit of lower electricity costs when powering their vehicle, but that impact is implicitly captured in the EV owner fueling savings. Those calculations are separated to avoid double-counting, and to enable transparent evaluation of the non-EV owner impacts.

[l] As noted in the methodology discussion in Section 4, this analysis identifies overall cost efficiencies at an aggregate level, quantified by an average cost of electricity indicator on a per-kwhr basis. In a competitive market, these cost improvements are expected to eventually flow through to end consumers. Exactly how those cost improvements are applied across rate classes or tariffs, or when those improvements impact bills, cannot be predicted since they depend on a wide variety of future market and regulatory factors. Energy contracting commitments may also impact the timing of when identified cost efficiencies are realized by end consumers.

becoming dominant longer term. This trend is summarized in the following chart, illustrating wholesale pricing effects (ChIPE) versus dilution impacts.



- Electricity cost savings scale strongly with aggregate EV adoption levels (% of light duty vehicle fleet). From a policy perspective, this implies that regardless of what actual EV adoption levels are achieved, incremental EV use generates incremental economic benefit for ratepayers overall. The following chart summarizes the correspondence between EV adoption and avoided electricity costs.



- It is important to emphasize that these benefits are realized by ratepayers overall, not just EV drivers, and reflect only savings delivered through lower electricity costs (not additional economic benefits as quantified below). The fact that overall electricity costs decline as a function of EV adoption is a primary conclusion of the benefit analysis. These economic ratepayer benefits are larger than projected program costs, as quantified more fully in the NET benefit tests in Section 7.

- As noted above, the electric cost reductions noted are based on the scenario where managed charging becomes dominant, as jumpstarted by the utility programs being proposed. The managed charging programs not only enable (and maximize) the potential economic benefits, but also avoid potential harm. For example, as an extreme worst case, if all charging was done at home, and all that charging started when EV drivers got home from work (say at 6PM), that would amplify the existing peak loads (especially during the summer), increase costs, and hasten the need for grid reinforcement (and associated costs). Assuming 75% of all PHEVs are on 1.4KW L1 chargers, 25% of PHEVs are on 7.2KW L2 chargers, and 100% of BEVs are on 7.2KW L2 chargers, in 2035 the projected EV fleet would create 951MW of incremental peak load, in a territory that normally has a PJM-coincident peak around 3,900 MW. That represents an increase of nearly 25% at the worst possible time. Again, this is a worst case scenario that is extremely unlikely to occur since a) some charging happens away from home, and b) even with residential charging, there is a natural spread in the evening. But this demonstrates the potential harm avoided by managed charging (in an extreme case), which both pushes the vehicle charging start past peak time, and when fully implemented, reduces vehicle charging peak load by about a factor of at least six (since it spreads 1-2 hour charging sessions out over a full 8 hour period overnight). The potential economic *harm* that could result from natural charging is not fully represented in this study.

5.2.2 Economic Benefits For Electric Vehicle Owners

After the EV purchase, significant economic benefits are realized by the EV owner through lower operating expenses. In particular, EV drivers "fuel" their vehicles with electricity rather than gasoline, and realize significant savings as a result. In addition, EV drivetrains are much simpler and require lower maintenance expense. Based on drive patterns specific to the DPL-DE territory, the study identified the following benefits for EV owner/operators:

- **In 2019 it will cost approximately 11.95 cents/mile to fuel an average traditional vehicle with gasoline, compared with approximately 6.16 cents/mile for EVs (both BEVs and PHEVs, blended results) – a reduction of about 48.4%.** This benefit increases over time, since the cost of gasoline is increasing faster than the cost of electricity. By 2035, EV drivers are projected to be realizing a 62.8% savings in fueling expense. These projections are conservative since a) they assume a reduction in gasoline prices over time due to softening demand for petroleum, and b) EV drivers are assumed to carry an additional expense sufficient to replenish lost revenues from avoided gas taxes (see Appendix A for more details).

- EVs are also expected to have lower maintenance costs due to the simpler drive train. A recent study by the American Automobile Association quantified maintenance expense for both traditional vehicles and EVs (see Appendix A). Based on these factors, as applied to the forecast for the DPL-DE territory, **owners of traditional vehicles are projected to pay approximately 9.26 cents/mile for maintenance of a traditional fueled vehicle, but only 7.97 cents/mile for an EV (blended rate for BEVs and PHEVs) in 2019**. This represents a 13.9% savings on maintenance.

- EV drivers therefore realize real savings through reduced "fueling" costs and maintenance expense. Taken together, and including gas tax replenishment, **EV drivers will realize over $1.1M in operating expense savings in 2019 (nominal sum of recurring annual benefits). This savings grows to $283.6M in 2035, and totals $1.0B over the period (with an NPV of $473.8M).** This represents an average of $2,056 in vehicle operating cost savings per EV sold over the period (nominal dollars). These benefits represent real and substantial cash flow savings for Delaware residents, much of which is returned to the local economy.

5.2.3 The Value Of Avoided Emissions

Increased EV use provides substantial reduction in air emissions and other pollutants, especially the GHG emissions associated with climate change. The emission reductions for CO_2, NOx, and SO_2 are described in Section 5.1, and represent an externality that delivers economic value to society through avoided emission costs. The value of avoided emissions is calculated on a per-ton basis based on impact factors developed by independent studies (see Appendix A for more details), as follows:

- **Avoided emissions (CO_2, NOx, and SO_2 combined) are projected to generate $213.5K in savings in 2019, growing to $83.5M per year in 2035.** These savings reflect the benefits of decreased CO_2 and NO_x net of the incremental cost associated with slightly increased SO_2 emissions.

- **The societal value of avoided emissions are projected to total $268.8M over the period (nominal sum of recurring annual benefits), with an NPV of $123.5M.**

- Note that these avoided emission benefits capture a wide variety of impacts, including the public health costs associated with air quality issues (at least in part[m]).

5.2.4 Combined Economic Benefits

EV adoption creates economic benefits through reduced electricity costs for ratepayers overall, reduced operating expenses for EV owner/operators, and societal value through avoided

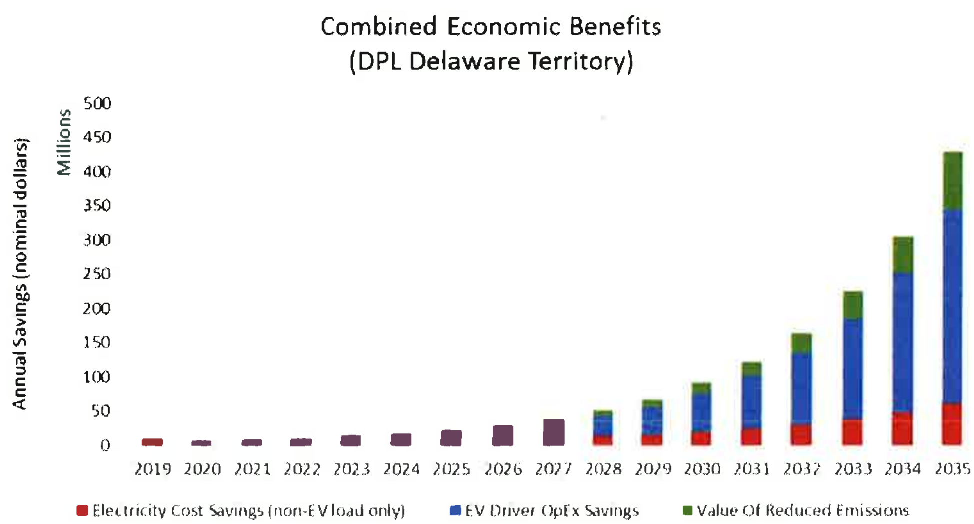
[m] Most studies on air quality impacts attempt to capture costs associated with the public health consequences of air pollution. In most cases, however, they acknowledge that health impacts are so large that their accounting is incomplete. As a result, these projections probably under-estimate the financial value of reduced emissions.

emissions of CO_2 and NOx. Taken together, these benefits combine to generate significant value across the impacted populations:

- Combined benefits are projected to total $9.4M in 2019, increasing to $428.8M per year in 2035. These impacts apply across multiple impacted populations, including ratepayers, EV drivers, and society at large.

- **Total benefits (not reflecting costs) are projected to total $1.6B over the period (nominal sum of recurring annual benefits), with an NPV of $767.6M.**

- There are significant benefits across all three populations, but operating expense savings for EV drivers becomes dominant over time. For context, residents of Delaware currently spend approximately $840M per year on gasoline use in light duty vehicles, and EVs are projected to cut those expenses in half[n]. This is a real cashflow savings delivered to every EV-household that will most likely flow into the local economy. This is a relatively equitable benefit opportunity, since any household that owns a vehicle can transition to an EV and realize the associated savings, especially as EVs become cost competitive with traditional vehicles. Emerging consensus is that transition will happen around 2025. The distribution of savings over time is illustrated in the following chart.



[n] The utility EV proposal also supports electrification of medium and heavy duty vehicles, especially electric school buses. That transition will also deliver significant benefits, beyond those quantified in this study focused on light duty vehicles.

5.2.5 One Time Benefits For EV Owners

In addition to the recurring benefits noted above, consumers that purchase a new EV may also benefit from a federal tax incentive to offset vehicle purchase costs. The amount of the credit varies by vehicle type and range, up to a maximum of $7,500. It is generally modeled as a benefit, since that economic incentive flows to DE residents from the federal government. That tax credit begins to decline when at least 200,000 EVs from a particular manufacturer have been sold, which market leaders (such as Tesla, Nissan, and Chevrolet) are expected to achieve in the next two years. An analysis of cumulative sales rates for different EV manufacturers was completed to determine the current average incentive level available, and the expected decline rate, based on volume-weighted sales in the U.S. The incentive is applied to all EVs purchased in the DPL-DE territory through 2027 (for BEVs) and 2029 (for PHEVs). **The federal tax incentive totals $83.6M over the period, with an NPV of $59.4M.**

6 KEY RESULTS: Program Costs

To properly consider the value of forecasted benefits, it is necessary to also consider potential costs. The study considered three categories of costs related to both the proposed utility EV program, and broader EV adoption as well:

1. **Utility Investments In Charging Infrastructure:** The utility is proposing a variety of customer programs, providing equipment and services that support customers driving an EV. These utility costs include the capital and expense associated with delivering those programs, and is quantified through the proposed program budget. Many of these programs can be considered investments in responsible grid integration of these new EV-charging applications, especially the managed charging programs, which have significant electricity-use and loading implications.

2. **Utility Investments In Grid Reinforcement:** Beyond the direct EV program, there may be the need for additional utility investment in grid reinforcement. As EV adoption grows, the utility will likely be required to deliver more electricity in support of vehicle charging. An estimate of these grid reinforcement investments, which are longer term in nature, has been provided to ensure complete characterization of EV adoption costs. As noted elsewhere throughout this document, the timing of potential reinforcement depends heavily on the success of managed charging programs, as is being initially established by the proposed utility program. Without managed charging, reinforcement requirements will be both earlier and larger.

3. **Investments By Non-Utility Entities:** In addition to actions by utilities, other market participants may be making incremental investments as part of more widespread vehicle adoption. Key examples include premiums associated with EV purchase, customer costs for charging infrastructure (net of utility contributions where applicable), and investments by private capital in public charging infrastructure. Long term estimates of those costs have been provided in support of the broader societal evaluation of net benefit.

6.1 Key Results: Utility Investments In Charging Infrastructure

DPL is proposing a customer support program for its Delaware territory, with multiple offers to address growing customer needs related to EV ownership and to address known adoption barriers that should encourage expanded EV adoption by new customers. Most of these programs are related to vehicle charging infrastructure, which is an appropriate role for the utility in the EV market ecosystem given its close technical connection with utility distribution infrastructure. Several of the programs focus on providing managed charging solutions for residential customers, which is a high impact strategy for minimizing EV charging impacts on the public grid, while also maximizing the economic benefits for other ratepayers (through more off-peak charging). These costs associated with the proposed programs are captured in the program budget, as summarized below.

Program Budget	Number Of Units	Budget
Offer 1: Residential Whole House TOU Rate	Unlimited	$0
Offer 2: Residential L2 (existing EVSE, with Fleetcarma)	50	$81,550
Offer 3: New Residential Smart L2 Charger (utility installed)	50	$462,500
Offer 4: New Multi-Family Smart L2 Charger	10	$78,000
Offer 5: Neighborhool Smart L2 Chargers	2	$30,000
Offer 6: Public DC Fast Chargers	2	$240,000
Offer 7: Electric School Buses With V2G	TBD	$400,000
Customer Enrollment and Outreach	N/A	$200,000
Admin, IT Costs, Reporting	N/A	$746,500
Total Program Costs:		**$2,238,550**

These costs were included as a utility program cost, recovered through rates, with all disbursements assumed to be in calendar year 2019.

6.2 Key Results: Utility Investments In Grid Reinforcement

EV charging increases the use of electricity, and longer term, could force reinforcement of utility infrastructure to accommodate those changes in load. These implications were not assessed in detail as part of this study, but Gabel has conducted in-depth engineering analysis of EV implications on utility infrastructure for other territories[8]. Those studies identified several general conclusions that we believe are applicable across a variety of territories, and those guidelines were used to estimate potential costs for grid reinforcement resulting from EV charging loads in the DPL-DE territory. Key guidelines include:

a) When the EV population is small (as an aggregate percentage), there is generally sufficient capacity within the distribution system to handle those incremental EV charging loads, although clustering affects (i.e. multiple EVs within a single neighborhood) could cause localized overload conditions.

b) During this early market phase, overload conditions, if they emerge, will be relatively localized and can be dealt with within the boundaries of routine maintenance and upgrade budgets.

c) Based on consideration of a wide variety of EV loading scenarios, in most cases overload conditions will emerge first on residential single phase transformers, and potentially on taps or overload protection components. Larger impacts on conductor capacity, sub-station elements, and transmission infrastructure are likely longer term, if they emerge at all. The timing, and impact scope, of EV charging depends heavily on residential EV charging patterns, and managed charging – if fully deployed – can defer (but not eliminate) these impacts in time.

d) Once the EV population is approximately equal to the number of single phase transformers, overload conditions will become more common since that condition begins to guarantee multiple vehicle charging loads on a single transformer. Past that point, more proactive grid reinforcement would be prudent to ensure responsible support for increased loading related to EV charging.

e) There are 56,613 single phase transformers in the DPL-DE territory. More proactive grid reinforcement therefore becomes necessary at approximately 7% EV penetration of the light duty fleet.

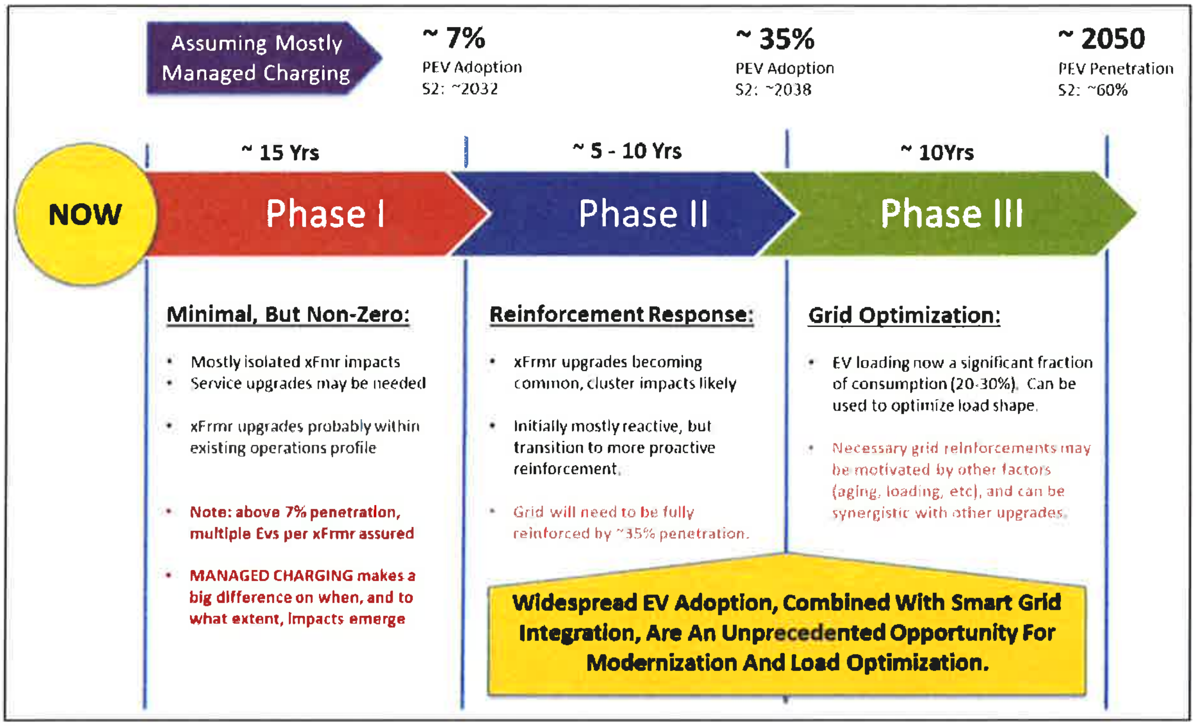
f) The impact analysis from other territories suggests that by the time the EV population is approximately five-times the number of single phase transformers, most grid reinforcement will need to be complete. In the case of the DPL territory in Delaware, this represents approximately 35% fleet penetration. The active grid reinforcement period is therefore expected to be between 7% and 35% EV penetration. For the EV forecast developed for the DPL-DE territory, this is projected to be from approximately roughly 2032 to 2038.

g) Distribution impacts will be felt most strongly on residential circuits, where the majority of vehicle charging electricity is delivered. Impact on commercial circuits, where workplace, public charging, and other specialized infrastructure (i.e. electric buses, etc.) have not been assessed in detail, but are generally expected to be less severe given a) the smaller number of installations and reduced energy delivery requirements (i.e. MWhrs delivered) in those charging segments, and b) the fact that those installations tend to require specialized interconnection engineering by the utility where load requirements can be more specifically accounted for.

h) Past approximately 35% EV penetration, vehicle charging represents a substantial load. A recommended utility priority during this mature phase of market development is using this quasi-dispatchable load to optimize grid loading and maximize economic benefits for ratepayers.

i) The above guidelines assume strong deployment of effective management charging programs, especially for residential customers. These programs must not just delay the start time of evening residential charging, but also spread that aggregate load over the full overnight period (~8 hours). If managed charging is not implemented, bigger impacts on infrastructure are likely to result.

j) The following diagram illustrates these three phases of market engagement based on changing infrastructure needs.



Based these guidelines, proactive grid reinforcement for the DPL-DE territory is assumed to take place from approximately 2032 to 2038, with approximately half the single phase transformer base being reinforced by 2035. A cost of $5,000 per transformer is assumed based on typical equipment and labor costs. Note that these upgrades, although motivated by EV loads, will also accomplish other reinforcement objectives, potentially including improved instrumentation, better resiliency, improved overall capacity, etc. It should also be noted that many of these transformers would require upgrade over a similar period, even if EV adoption did not happen. This assumption of full transformer upgrade is therefore extremely conservative, and probably overstates the costs that should be booked to EV adoption.

Based on these schedule and cost assumptions, **the total utility cost for grid reinforcement is estimated to be $131.1M (nominal sum) from 2032 – 2035, with an NPV of $56.1M.** Additional costs related to sub-station or transmission upgrades, if required, are not reflected[o].

6.3 Key Results: Estimated Non-Utility Costs

A market transition to greater use of EVs implies costs for market entities other than utilities, including EV owners, and other investors in vehicle charging infrastructure. These other multi-party costs – although outside the boundaries of utility investment – should be considered to have a comprehensive

[o] We are not aware of significant sub-station or transmission upgrades being identified as required in any other jurisdictions, even California where EV penetration is much higher. While we haven't studied the DPL-DE territory at an engineering level, our high level assessments of other territories are that the risks emerge first at the single phase transformer level (and perhaps other related feeder equipment), and that substation/transmission impacts, if they arise at all, would arise later.

view of total costs appropriate for the broader cost tests. The analysis considered the following components of non-utility costs:

1. **Incremental Vehicle Purchase Price:** In the current market, EVs are perceived to cost more than traditional gasoline vehicles. This conclusion is based on the fact that the average MSRP for all EVs on the market is higher than the average MSRP for all traditional gasoline vehicles on the market. Although this statistic may not be representative of how actual consumers make decisions at a transaction level, it is clear that this is the market *perception*, and consideration of the perceived premium is included in this benefit-cost analysis to make the analysis as comprehensive and transparent as possible. The premium was based on a study done in California on the average premium associated with EVs, as used by San Diego Gas and Electric in their 2014 EV program filing[9]. Those numbers reflect a purchase price premium of $8,694 for BEVs, and $8,081 for a PHEV (with at least 40 miles of electric range), as projected to 2019. Those premiums are estimated in the California study to decline by 10% a year, and this trend is assumed for this analysis through 2030, after which the premium is assumed to be zero (i.e. EVs are price competitive with traditional gasoline vehicles across a wide range of vehicle categories)[10]. The estimated purchase price premium for each year is applied to the total number of EVs sold in the DPL-DE territory over the analysis period, by BEV or PHEV vehicle type, to quantify this total market impact. This premium is estimated to total approximately $141.8M over the period ($94.0M NPV). Which is a relatively small fraction of the estimated $8-10B projected to be spent on new EVs in the DPL territory of Delaware through 2035.

2. **Non-Utility Investment In Charging Infrastructure:** A wide variety of market participants help pay for charging infrastructure, under a variety of business models and ownership paradigms. This makes estimates of total charging infrastructure costs complicated. However, the charging infrastructure required in key charging segments can be estimated based on the EV adoption forecast. The full cost of that infrastructure was quantified as part of the analysis (using typical installation costs for equipment and labor). The difference between this total infrastructure cost, and the costs proposed to be carried by the utilities through the proposed program, represents the non-utility investments in charging infrastructure. Under this methodology, the combination of utility investments and non-utility investments fully capture infrastructure investment requirements over time. Infrastructure needs were estimated for residential, workplace, public L2, and public DCFC charging segments with costs estimated using typical cost factors obtained from other utilities and industry. In general, these cost profiles include the cost of new service (where required), infrastructure to the EVSE installation, and the EVSE equipment (and network services where applicable). The amount of infrastructure needed across the above four segments was calculated to meet projected USAGE requirements, based on infrastructure supply factors from the recent U.S. Department of Energy (DOE) EV charging infrastructure plan[11]. The following table summarizes key assumptions related to the charging infrastructure requirement estimates:

Charging Infrastructure Estimating Factors	Factor	Units	Trend
Capacity Requirements (Plugs per EV)			
Residential/Fleet (chargers for BEVs)	100.0%	% new BEV sales	Constant -> 2035
Residential/Fleet (chargers for PHEVs)	25.0%	% new PHEV sales	Constant -> 2035
Workplace plugs per EV (BEV & PHEV)	0.03000	Plugs/EV	Constant -> 2035
Public L2 plugs per EV (BEV and PHEV)	0.02200	Plugs/EV	Constant -> 2035
Public DCFC plugs per BEV	0.00387	Plugs/BEV	Constant -> 2035
Cost Factors (Per Plug, equipment and labor)			
Total Cost per plug: residential/fleet L2	$1,631	$/plug	Constant -> 2035
Total Cost per plug: workplace L2	$6,000	$/plug	Constant -> 2035
Total Cost per plug: public L2	$9,000	$/plug	Constant -> 2035
Total Cost per plug: public DCFC (at least 50KW)	$120,000	$/plug	Constant -> 2035
Infrastructure Requirements (plugs)			
New Residential/Fleet L2 Plugs	140,737	Plugs	Total Thru 2035
New Workplace L2 Plugs	3,266	Plugs	Total Thru 2035
New Public L2 Plugs	2,042	Plugs	Total Thru 2035
New Public DCFC plugs	257	Plugs	Total Thru 2035

Total costs for the four identified charging segments, net of utility contribution, are estimated to total $297.4M over the period, with an NPV of $137.8M. Note that some of these assets are for the use of individual vehicle owners (such as private residential settings), others are quasi-public since they are used by multiple approved uses, and the public assets are used by the entire EV ownership fleet. The above numbers represent initial investment for the infrastructure, which may be recovered from EV drivers through usage charges. These non-utility costs are included in the benefit-cost analysis to ensure a broad and comprehensive accounting of net benefit, especially for the broader tests like the TRC and SCT, which are described below in Section 7.

Note: this analysis demonstrates that the utility investment is highly leveraged, meaning that for every utility dollar spent, significant additional investments are being made by other parties. The utility program represents a $2.2M program investment[p] that is matched by $297M of non-utility investment in charging infrastructure as well. The proposed utility programs do not cover the full costs required for infrastructure, and utility investment is matched by significant non-utility investment as well. Since these early stage utility programs help to "seed the market", significant future infrastructure is assumed to be built (especially for residential) without direct utility investment. In addition, the utility programs for public fast charging, are considered highly leveraged since they address key

[p] The cost model also accounts for additional potential utility investment longer term for grid reinforcement to support EV-induced loads. These costs are included to ensure robust coverage of potential costs and conservative net benefit estimates, but may not be required depending on the success of managed charging programs. Note that other investments are also being made – beyond that required for charging infrastructure – including investment in the EVs themselves. Those non-utility investments are also enabled by the utility programs that encourage adoption.

consumer adoption barriers that are expected to significantly increase adoption and grow industry scale, leading to lower EV costs for all consumers medium term.

7 KEY RESULTS: Net Benefit-Cost Tests

The benefits of EV adoption (summarized in Section 5), and the associated costs (summarized in Section 6), can be combined to establish NET benefit in support of determining merit for the proposed programs. Comparing benefits and costs can be complicated, however, since in some cases the population that realizes a benefit may be different than the population that bears the cost. This is particularly true for EVs, since there are a variety of impacted populations involved (ratepayers, EV drivers, society at large).

It is therefore useful to consider a variety of net benefit-cost tests that carefully combine benefits and costs to characterize different policy perspectives on merit. For energy efficiency (EE) and demand response (DR) programs, there are five standard tests used to provide these multiple perspectives. These tests are as defined in the California Standard Practice Manual, which is widely used for evaluation of merit for clean energy utility program filings[12]. These merit tests provide the foundation to determine how benefits and costs are combined to calculate a net impact, with different tests reflective of different impacted population combinations.

The standard tests defined in the EE/DR protocol are not easily applied to EV programs as originally defined. The EE/DR methods were designed to assign merit to reductions in consumption, whereas EV adoption increases electricity use. In addition, there are a variety of categories (such as charging infrastructure investment) that are not naturally represented in the standard tests. These tests can be adapted, however, to provide similar forms of evaluation.

At the current time, however, there is no well-established consensus on how the standard tests should be adapted to utility EV programs. As part of the study, a detailed review of various filings and consultant studies was completed to synthesize "best practice"[13] [14] [15], and determine where common methods or other agreement exist. Although there was wide diversity on what elements were included in each test, and variations in how those elements were defined or calculated, there were several points of agreement on the conceptual structure for merit tests adapted for the evaluation of utility EV programs. Based on that assessment, the following adapted tests were used:

1. **Adapted Ratepayer Impact Measure (RIM):** The RIM test measures what happens to customer rates due to changes in utility revenues and operating costs caused by the program. Rates will go down if the change in revenues from the program is greater than the change in utility costs. Conversely, rates will go up if revenues collected after program implementation are less than the total costs incurred by the utility in implementing the program. For this analysis, changes in utility revenues are captured through the NET impact on electricity rates (as recognized by the consumer), and costs are based on direct utility investments. This test indicates the direction and magnitude of the expected change in customer rate levels. The RIM test is a strict protocol where the cost and benefit populations are strongly aligned: costs carried by utility customers for the EV program are compared with the energy cost savings that accrue to those same utility customers through changes in electricity costs. This test excludes numerous other benefits that are known to exist, especially regarding EV owner savings on operating expense and

environmental benefit. This is a useful test, however, for specifically evaluating the impact on utility customers without consideration of externalities.

2. **Adapted Societal Cost Test (SCT):** The SCT measures the net costs of a program as a resource option based on the total costs of the program, including both the utility's costs and the costs incurred by all other market participants. Similarly, all benefits are included, regardless of the impacted population. The SCT is an intentionally broad test that helps determine if society is better or worse overall as a result of implementing the proposed programs.

3. **Adapted Total Resource Cost Test (TRC):** The TRC is very similar to the SCT, and it measures the net costs of a program as a resource option based on the total costs, including both the utility costs of the program and costs incurred by other market participants. Benefits that are realized by direct program participants are included. The TRC is different than the SCT, however, in that it does not include consideration of the broader environmental benefits that accrue to society at large. The TRC helps determine if the participants that are directly affected (typically within the utility territory) are better or worse overall as a result of implementing the proposed programs, independent of broader externalities that might also apply.

The two remaining standard tests were not included in the evaluation. Specifically, the Program Administrator Cost (PAC) test was not included, since program administrator costs (if any) are completely unknown known at this time. The Participant Cost Test (PCT) was not included since the concept of a "participant" is harder to clearly define in the case of EV programs, especially given that many of the proposed offers are intended, by design, to "seed the market" and have ripple-effects that influence other (and future) EV buyers. The public charging programs, in particular, have a broad and evolving base of "impacted customers" that make a clear definition of the PCT difficult. The three tests defined above, however, provide a comprehensive collection of perspectives to inform evaluation of EV program merit.

Based on synthesis of filing and study examples as noted above, the following inventory of benefits and costs were used to calculate the three adapted merit tests. All of these benefits and costs were described and quantified in detail in Section 5 (benefits) and Section 6 (costs). All costs and benefits are quantified over the analysis period.

a) **Avoided Wholesale Electricity Costs (ChIPE):** Projected reductions in wholesale unit costs due to the optimization of the aggregate load profile, particularly the increased fraction of overall consumption in lower cost, off-peak times. This savings is a result of Charging Induced Price Effect (ChIPE), and was determined through detailed hour-by-hour dispatch simulation of generation assets in PJM as allocated to DPL-DE induced load. The reduced electricity unit-costs are applied to the non-EV electricity consumption only, and are potentially realized by all utility ratepayers.

b) **Avoided Non-Wholesale Electricity Costs (Dilution):** An estimate of all other non-wholesale costs, especially transmission, capacity, and utility distribution costs. Any EV charging-induced increases in capacity or transmission costs, as determined by increases in the PJM-coincident peak (in MW), are calculated based on projections of PJM capacity and transmission costs. Distribution costs are based on detailed analysis of current utility revenue requirements. Overall, after accounting for the impact of transmission and capacity costs, there is a net reduction in effective $/kwhr rates due to dilution of these costs over greater kwhrs-consumed.

c) **NET Value Of Avoided Emissions:** The tailpipe emissions for electrically-fueled miles are zero, replaced by incremental emissions at a power plant that is more efficient and can include carbon-free sources. The NET impact is a significant reduction in emissions, especially CO_2 and NOx, while SO_2 emissions increase slightly. These emission impacts are calculated using the same dispatch simulation described above. The NET value reflects the benefit of reduced CO_2 and NOx, as offset slightly by an increase in SO_2.

d) **NET Savings On EV Driver Operating Expense:** The benefit EV owners gain from using electricity rather than gasoline, and reduced maintenance expenses for EVs due to the simplified drivetrain. The long term NET savings reflect the combination of avoided gasoline costs, incurred electricity for charging, and avoided costs for maintenance. This analysis also assumes that EVs incur an additional expense that replenishes lost gas tax revenues to ensure infrastructure funding.

e) **Value Of Federal Tax Credits For EV Purchase:** The federal tax incentive provided for EVs, declining over time, based on distinct eligibility rules for BEVs and PHEVs.

f) **Utility EV Program Investments In Charging Infrastructure:** Capital and expenses for the proposed utility EV program, to be recovered from utility customers through rates. The majority of these programs are related to providing charging infrastructure and encouraging the adoption of managed charging solutions.

g) **Utility Investments In Marketing And Consumer Outreach:** Expense associated with proposed consumer education programs for both customer adoption into the planned programs, and more general EV awareness building.

h) **Other Utility Program Investments:** Related costs, including Administration, Information Technology costs, and program reporting.

i) **Utility Investments in Grid Reinforcement:** Estimated costs for utility reinforcement of the distribution system medium term, including replacement of approximately half of all single phase transformers by 2035.

j) **Non-Utility Investments In Charging Infrastructure:** Potential costs incurred by non-utility market participants for charging infrastructure over the analysis period. These costs are estimated based on usage requirements using infrastructure factors from the DOE national EV charging infrastructure plan, NET of any investments made by the utility through the proposed programs.

k) **EV Driver Vehicle Purchase Premium:** An estimate of the purchase premium paid by EV owners, declining over time as EV prices continue to drop due to lower battery prices, increasing industry scale, and competition.

The following chart summarizes how each of these elements were included in the three adapted merit tests:

Gabel EV Standard Test Methodology				
Impact To Be Included	**Population Impacted**	**Adapted-RIM**	**Adapted-SCT**	**Adapted-TRC**
Avoided Wholesale Generation Costs (ChIPE)	All Ratepayers	Benefit	Benefit	Benefit
Avoided C/T/D Costs (through dilution)	All Ratepayers	Benefit	Benefit	Benefit
NET Value Of Avoided Emissions (CO2, NOx, SO2)	Society		Benefit	
NET Savings on OpEx For EV Drivers ("fueling" and maintenance)	EV Owners		Benefit	Benefit
Value Of Federal Tax Credits For EV Purchases	EV Owners		Benefit	Benefit
Utility Investments In Charging Infrastructure	All Ratepayers	Cost	Cost	Cost
Utility Investments In Marketing And Customer Outreach	All Ratepayers	Cost	Cost	Cost
Other Utility Program Investments (admin, billing, etc)	All Ratepayers	Cost	Cost	Cost
Utility Grid Reinforcement	All Ratepayers	Cost	Cost	Cost
Non-Utility Investments In Charging Infrastructure	EV Owners And Others		Cost	Cost
EV Driver Investments: Vehicle Purchase Premium	EV Owners		Cost	Cost

All three adapted tests have been applied to the proposed DPL-DE program, consistent with the EV adoption forecast outlined in Section 3. All three tests delivered both a positive Benefit/Cost ratio (greater than 1.0) and a positive Net Present Value (NPV) over the analysis period, as defined in the sections below.

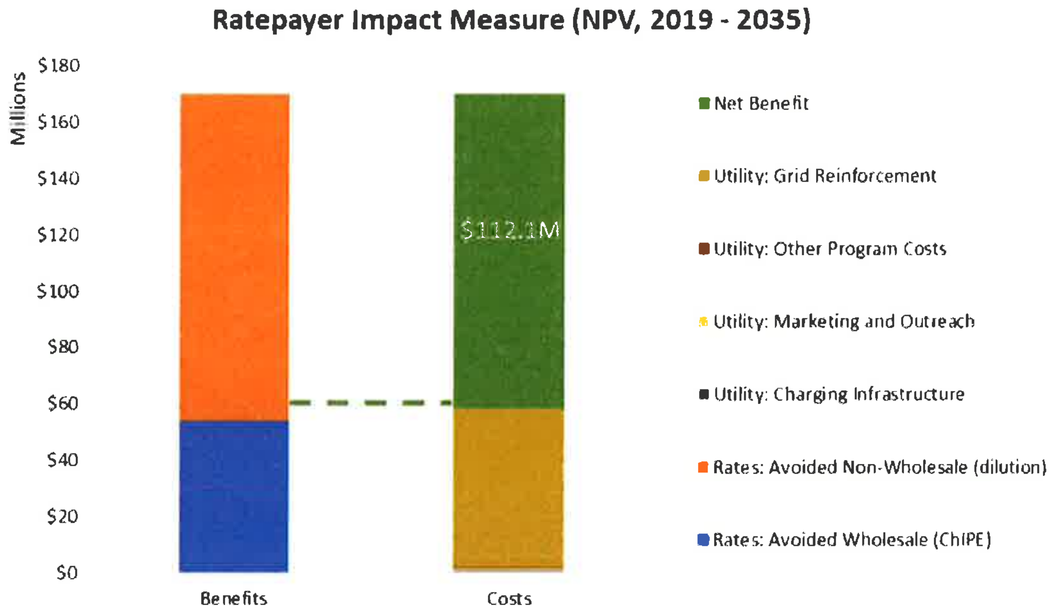
7.1 Key Result: The Adapted Rate Impact Measure (RIM)

The adapted Rate Impact Measure (RIM) yielded a Benefit/Cost ratio of 2.92, and a projected NET benefit (after costs, NPV basis) of $112.1M through 2035. Details are provided in the table below.

Adapted RIM Test	
	NPV (2019 - 2035)
Benefits Delivered To Rate Payers (non-EV load only)	
Benefit: Avoided Wholesale Generation Costs (ChIPE, $)	$53,912,238
Benefit: Avoided Non-Wholesale (C-T-D) Costs Thru Dilution ($)	$116,377,949
Total Avoided Electricty Costs ($):	**$170,290,187**
Costs - Utility Investments Recovered From Rate Payers	
Costs: Utility Investments In Charging Infrastructure ($)	$1,224,692
Costs: Utility Investments In Customer Acquisiton and Outreach ($)	$189,573
Costs: Utility Investments In Other Program Costs ($)	$707,583
Costs: Utility Investments In Grid Reinforcement ($)	$56,109,509
Total Utility Investment Costs ($):	**$58,231,357**
Total NET Benefit (benefits minus costs, NPV):	**$112,058,830**
Total Benefits (NPV):	$170,290,187
Total Costs (NPV)	$58,231,357
Benefit To Cost Ratio (based on NPV):	2.92
Net Impact Per PEV Purchased Over The Period (based on NPV)	$486
Average Net Benefit Per Year (2019-2035, $/Yr):	$11,315,015

Given the very narrow range of benefits considered in this simple test, this outcome is significant. It demonstrates that utility investment in EV programs does not suffer from the "Reverse Robin Hood Effect": utility investments that are recovered from all ratepayers generate benefits that flow back to all utility customers, with net positive benefit. Put another way, action by some utility customers (driving an EV and charging mostly at home, mostly off peak) has a broader economic impact across the entire rate base.

The following diagram compares the costs and benefits associated with the RIM test, and the net benefit that results.

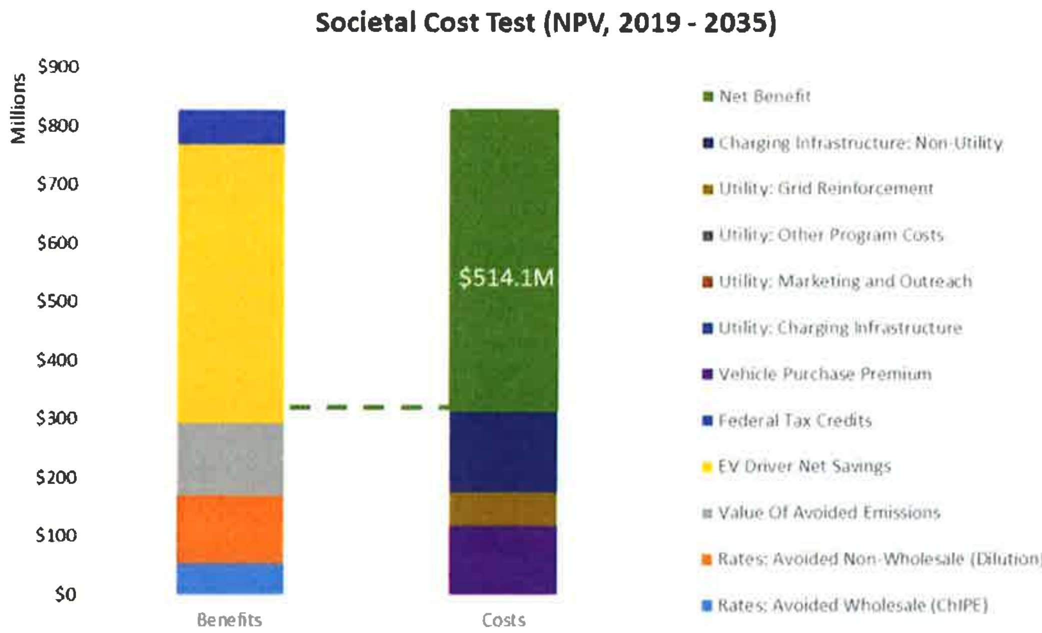


7.2 Key Result: The Adapted Societal Cost Test (SCT)

The adapted SCT provides a more comprehensive view of results, and yielded a Benefit/Cost ratio of 2.64, and a projected NET benefit (after costs, NPV basis) of $514.1M through 2035. Details are provided in the table below.

Adapted SCT	
	NPV (2019 - 2035)
Benefits Delivered To Rate Payers (non-EV load only)	
Benefit: Avoided Wholesale Generation Costs (ChIPE, $)	$53,912,238
Benefit: Avoided Non-Wholesale (C-T-D) Costs Thru Dilution ($)	$116,377,949
Total Avoided Electricty Costs ($):	**$170,290,187**
Benefits Delivered To Society At Large	
Benefit: Value Of Avoided Emissions ($)	**$123,546,849**
Costs And Benefits For EV Owner/Operators	
Cost: Vehicle Purchase Premium	$116,901,771
Benefit: Net Value Of Savings On Operating Expense ($)	$473,804,080
Benefit: Federal Tax Credits	$59,393,673
Total Net Benefits For EV Owners/Operators ($):	**$416,295,982**
Costs - Utility Investments Recovered From Rate Payers	
Costs: Charging Infrastructure ($)	$1,224,692
Costs: Customer Acquisiton and Outreach ($)	$189,573
Costs: Other Program Costs ($)	$707,583
Costs: Grid Reinforcement ($)	$56,109,509
Total Utility Investment Costs ($):	**$58,231,357**
Costs - Non-Utility Market Participants	
Costs: Charging Infrastructure	**$137,810,468**
Total NET Benefit (benefits minus costs, NPV):	**$514,091,193**
Total Benefits (NPV):	**$827,034,789**
Total Costs (NPV)	**$312,943,596**
Benefit To Cost Ratio (based on NPV):	**2.64**
Net Impact Per PEV Purchased Over The Period (based on NPV)	**$2,231**
Average Net Benefit Per Year (2019-2035, $/Yr):	**$63,495,806**

The following diagram compares the costs and benefits associated with the SCT, and the net benefit that results.



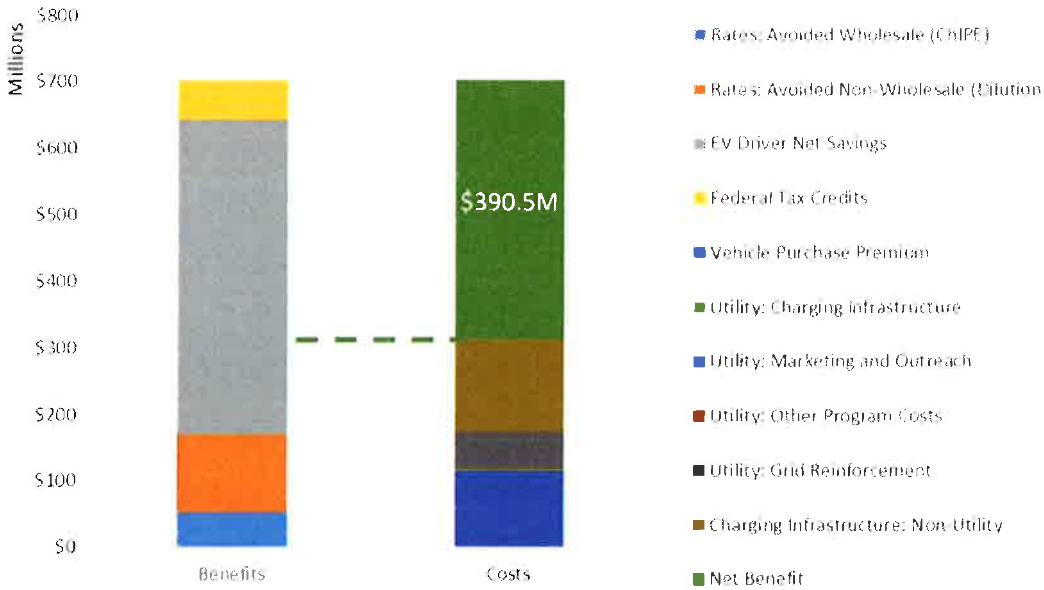
7.3 Key Result: The Adapted Total Resource Cost (TRC)

The adapted TRC yielded a Benefit/Cost ratio of 2.25, and a projected NET benefit (after costs, NPV basis) of $390.5M through 2035. Details are provided in the table below.

Adapted TRC	
	NPV (2019 - 2035)
Benefits Delivered To Rate Payers (non-EV load only)	
Benefit: Avoided Wholesale Generation Costs (ChIPE, $)	$53,912,238
Benefit: Avoided Non-Wholesale (C-T-D) Costs Thru Dilution ($)	$116,377,949
Total Avoided Electricty Costs ($):	**$170,290,187**
Costs And Benefits For EV Owner/Operators	
Cost: Vehicle Purchase Premium	$116,901,771
Benefit: Net Value Of Savings On Operating Expense ($)	$473,804,080
Benefit: Federal Tax Credits	$59,393,673
Total Net Benefits For EV Owners/Operators ($):	**$416,295,982**
Costs - Utility Investments Recovered From Rate Payers	
Costs: Charging Infrastructure ($)	$1,224,692
Costs: Customer Acquisiton and Outreach ($)	$189,573
Costs: Other Program Costs ($)	$707,583
Costs: Grid Reinforcement ($)	$56,109,509
Total Utility Investment Costs ($):	**$133,305,550**
Costs - Non-Utility Market Participants	
Costs: Charging Infrastructure	**$137,810,468**
Total NET Benefit (benefits minus costs, NPV):	**$390,544,344**
Total Benefits (NPV):	**$703,487,940**
Total Costs (NPV)	**$312,943,596**
Benefit To Cost Ratio (based on NPV):	**2.25**
Net Impact Per PEV Purchased Over The Period (based on NPV)	**$1,695**
Average Net Benefit Per Year (2019-2035, $/Yr):	**$47,685,141**

The following diagram compares the costs and benefits associated with the TRC test, and the net benefit that results.

Total Resource Cost Test (NPV, 2019 - 2035)



8 Discussion

The merit test results presented in Section 7 build upon detailed analysis of the benefits that result from EV adoption, with projected impacts across a variety of populations. In most cases, assumptions and methodology choices were made to ensure the analysis was as transparent and conservative as possible. Taken together, we believe these benefit estimates to be a lower bound on the actual impact. There are a variety of factors that were not included in the analysis, which if accounted for, would likely make the benefit portfolio even stronger:

a) Wholesale market modeling demonstrates that EV charging – if done at optimal off-peak times – will decrease the average wholesale cost of electricity. This analysis accounts for that benefit *only for DPL-DE consumers.* In fact, that impact would apply across all of PJM, and could deliver reduced electricity costs to consumers in other states as well. That benefit is not accounted for. In addition, this analysis does not account for EV adoption that may be happening in other PJM states, and which could beneficially impact Delaware consumers as well. There will be a synergistic impact for all PJM consumers from EV adoption happening simultaneously in multiple states, and that dynamic is likely to increase the electricity cost benefits quantified in this Delaware-focused analysis.

b) This analysis makes very conservative assumptions about long term gasoline prices. The EIA projection for gasoline prices (as scaled to Delaware conditions) was used through 2025, but only HALF the EIA growth rate was used from 2026 to 2035. This assumption is consistent with widespread EV adoption, which should soften overall petroleum demand and depress prices. Similar dynamics are already evident in the global market due to EV adoption in Europe and China especially. If, however, gasoline prices retain strength, or are more in line with the long term EIA forecast, then the savings projected for EV drivers fueling their vehicles with electricity rather than with gasoline could be higher, potentially much higher.

c) If gasoline prices decline long term, in response to widespread EV adoption, those lower prices will benefit NON-EV drivers fueling their traditional vehicles as well. This impact is potentially very large since it applies to all drivers. That potential impact is not considered in this analysis.

d) The analysis assumes an upgrade of approximately half of the single phase transformer base by 2035. Those upgrades will likely bring benefits beyond just supporting additional EV load. Instrumentation, overall capacity, and resiliency of the grid could also be improved. In addition, many of the transformers would have likely been replaced for other reasons (age, loading, etc.), in which case assuming an EV-driven replacement could be duplicative. To be conservative, however, this analysis "booked" the costs of all transformer replacements solely against EV-related benefits, but it is possible that costs could be lower (since some transformers are already being replaced for other reasons), and not all benefits associated with those upgrades are captured.

e) This initial analysis quantified the value of reduced emissions based on CO_2, NO_X, and SO_2 impacts only. EVs are also likely to reduce other criteria pollutants, especially volatile organic compounds (VOCs) and particulates. More complete consideration of other emissions and pollutants could increase those benefits substantially.

f) Managed charging only captures trough fill of the aggregate load curve (i.e. adding additional load to underutilized periods at night, through one-way charging), not peak shaving (i.e. using electricity stored in vehicles to offset peak generation through two-way charging). If those impacts are included, cost efficiencies increase and electricity costs could decline further.

g) Economic impacts of public health implications are probably significantly under-represented. The studies that provided the factors used to assess the economic value of reduced emissions acknowledge that they only partially account for public health impacts.

h) The full benefits of increased electricity infrastructure utilization may not be fully captured, especially for the power plant fleet. The forecasts on capacity costs, in particular, assume essentially "business as usual" regarding plant utilization. To the extent a more optimal load increases capacity factors across the generation fleet, capacity prices may decline as well. That would increase the benefit-cost realized by electricity consumers.

i) This analysis considered only light duty vehicles consuming gasoline, which accounts for the overwhelming majority of the vehicle miles travelled. However, electrification is beginning to grow in other vehicle segments as well, including buses, delivery trucks, and long haul transport. Diesel displacement by electrified vehicles is very likely to happen in lockstep with the light duty vehicle transition, and would provide significant additional benefits. Note that the utility EV program proposal should help to encourage electrification for medium and heavy duty vehicles, especially school buses, but those diesel-specific impacts are under-represented in this analysis.

j) The results of the asset dispatch simulation are predominantly based on "business as usual" assumptions about the generation fleet in PJM. If the grid gets cleaner in parallel with increased EV adoption, the benefits quantified in this study (especially the environmental ones) will be stronger. Note that the utility program intends to secure 100% class I renewable energy for all the electricity consumed by the public charging stations, as well as a clean energy option for residential customers (see Section 5.1). That impact was not quantified in this study, and if it were, would make the benefits noted stronger.

Beyond the economic and environmental impacts of increased EV adoption quantified in this study, there are a wide variety of more qualitative benefits that also apply. Based on a survey of existing literature, the following general outcomes could reasonably be expected to result from increased EV use, most of which are directly related to the reduced use of petroleum.

a) The beneficial impact of reduced air emissions will likely accrue disproportionally along travel corridors and in urban centers. There are therefore significant social equity implications to widespread EV adoption resulting from improvements to air quality in urban centers and along travel corridors where low income and environmental justice communities are often located.

b) The EVs introduced to date have been well rated from a safety perspective, and EVs benefit especially from a low center of gravity due to the typical under-carriage placement of the batteries. Widespread EV adoption could therefore reduce vehicle-related safety risks for the traveling public.

c) EVs are much quieter than traditional vehicles, and reduced vehicular noise will be a significant benefit along some travel corridors. There is a related risk that needs to be addressed as well, which is that EVs are so quiet that pedestrians may be unaware of approaching vehicles, especially those pedestrians that suffer from sight-challenges and depend on vehicle noise indicators to navigate safely. Standards are now emerging that will require a minimum level of warning noise at low speeds to address this concern.

d) EVs can be used to provide power to the home in the event of a grid outage, although this feature is still a new capability for most currently available vehicles. There are therefore potential resiliency benefits from "stored on-site power" in the residential sector.

e) A significant fraction of the US trade deficit is related to the use of imported petroleum. As EV use increases, petroleum use, especially imports, will decline. Widespread vehicle electrification could therefore have a strong positive impact on the overall US trade balance.

f) The geopolitical implications of the existing petroleum industry are substantial, including impacts on where conflict zones emerge, global trade balances, the fact that petroleum revenues are a primary source of income for terrorist organizations, etc. The geopolitical implications of a world with dramatically reduced petroleum use are profound.

g) The majority of the transportation sector depends primarily on a single source of energy: petroleum. An added advantage of "fueling" vehicles with electricity is that electricity generation benefits from a highly diversified base of primary sources – potentially including lower carbon sources in the future. Overdependence on petroleum as the sole source for transportation energy is evident through the recurring impact increased oil prices have on the broader economy. Vehicle electrification therefore provides significant strategic benefit through diversification of the primary energy supplies that support the crucial transportation sector.

h) This analysis assumed "business as usual" for both the existing generation base and future additional capacity, consistent with current industry practice. However, profound shifts are happening in the supply mix in parallel with growing EV adoption, particularly regarding a shift to class I renewable sources. There are likely significant synergies between the *simultaneous* adoption of EVs and a shift to carbon free renewable generation. This synergy happens in both directions: a) the existence of more grid-integrated storage (in the form of vehicle batteries) could help firm the intermittent supply associated with solar and wind, and b) every carbon-free kwhr generation by solar or wind is not just displacing traditional fossil-fuel generation, but also highly inefficient combustion of petroleum in vehicles. As the supply mix becomes cleaner, the "clean-up" factors noted in this analysis, especially regarding reduced $CO2$ and NOx, will become stronger and result in greater reduced emissions benefit.

Vehicle electrification is happening in parallel with other profound changes in personal mobility, including a) autonomous vehicles, b) an increase in car sharing and ride hailing, c) connected vehicles (that are communicating with each other, with the road, and with external information points), and d) an increased focus on the needs of urban drivers. Some projections of EV adoption attempt to account for these simultaneous trends, including an eventual decline in personal vehicle ownership. We acknowledge the existence of these parallel trends, but our research into this topic suggests that although WHO is doing the driving, or who OWNS the vehicle may be changing, the amount of travel activity changes little. For example, if private vehicle ownership goes down due to car sharing, average miles traveled per vehicle goes up since shared vehicles have much higher utilization. For purposes of this analysis, the primary consideration is the amount of energy involved, and that is tied to the amount of travel being done (and other factors like vehicle efficiencies, etc.). Therefore, to simplify the analysis and minimize the number of assumptions that must be made, this study assumed a continuation of current vehicle and travel trends, as justified by the expectation that total energy usage projections remain representative despite the possibility of other simultaneous changes taking place.

Much of the infrastructure analysis focused on residential charging (where most of the charging is actually done), workplace L2 chargers, and public chargers (L2 and DCFC) – consistent with current industry experience. New trends are emerging in which specialized charging infrastructure may be advantageous. Examples include "charging barns" (for taxis or shared vehicles), community charging hubs, en-route chargers for electric buses, and very high power chargers for long haul vehicles. These changes probably won't impact the ENERGY assumptions this study is based on, but may call for the development of more specialized charging infrastructure, typically on commercial circuits, with a need for specialized interconnection engineering.

Finally, the study recognizes that the utility program is proposed for TWO reasons: 1) serving a growing new need by consumers responsibly (vehicle charging), and 2) addressing adoption barriers that help encourage adoption. In the first case, utility involvement is *needed* in response to changing consumer loads, while in the second case utility programs are *desired* since they can reduce consumer barriers, which increases adoption, ensures and maximizes benefits, and helps ensure that those benefits are delivered equitably to utility customers. This analysis is based on the expectation that the proposed utility program serves both needs. EV charging is a new load that must be supported by the utility, just like any other emerging load trend in the past (such as home air conditioning) – so part of the utility proposal is needed to accommodate this change in consumer need. In particular, it is prudent for the utility to encourage managed charging so as to minimize potential harmful impacts on the grid (longer term), and to maximize benefits. At the same time, however, the program also addresses barriers that ensure a stronger growth profile and therefore helps realize the substantial benefits that widespread EV use can bring. The EV adoption growth assumptions are predicated on removal of current barriers, for which the utility program is making a critical contribution. The EV adoption forecast is therefore a combination of existing adoption rates within the territory, as augmented by projections of a strong growth due to a supportive marketing environment as enabled (in part) by the utility program. Deployment of public DCFC infrastructure is expected to be a particularly impactful market development investment, since a) lack of convenient public charging infrastructure is one of the most significant consumer adoption barriers, b) those assets are used by all EV drivers, and c) some of the costs of those systems are recovered through user fees.

9 Conclusions

This study quantified the impacts that increased EV adoption are projected to have in the DPL-DE territory. Beneficial impacts were identified based on lower overall electricity costs, reductions in emissions and other pollutants, and cash flow savings for EV drivers through lower vehicle operating expenses. These recurring annual benefits are substantial, totaling a projected $1.6B through 2035 (nominal sum), with an NPV of $767.6M and an average benefit of $94.6M per year over the period. The lower electricity costs accrue to ratepayers overall (not just EV drivers): these utility customers are projected to average $26.50 per household in annual savings over the period. This savings is significantly larger than projected household bill increases from the proposed utility programs. EV drivers are also projected to save an average of $2,056 per year (per EV) on operating expense over the period.

This growing use of EVs is projected to displace 310 million gallons of gasoline over the period, resulting in a reduction of CO_2 emissions by 2,076,234 tons by 2035. Electricity consumption is projected to increase by 572 GWhrs per year in 2035, and vehicle charging will induce an additional 2,152,347 MWHrs of electricity sales over the period. If managed charging becomes dominant, there is projected to be only a modest impact on either generation assets or transmission capacity: the PJM-coincident peak increases by only 36.5 MW in 2035. Encouraging optimal off-peak charging is a key objective of the residential smart charging program included in the utility proposal. Absent influences to ensure residential charging at optimal times, peak loading impacts induced by vehicle charging are likely be much larger – in an extreme worst case, adding as much as 25% to peak loading by 2035.

In support of these increased loads, and to reduce consumer adoption barriers and encourage strong long term EV growth, the utility is proposing a program that provides equipment and services, primarily for EV charging infrastructure. After considering the costs of the proposed utility support program, the costs of grid reinforcement that may be required, and costs by others as part of EV adoption, the net benefit is projected to be positive in all cases. Three merit tests – based on adapted versions of the RIM, SCT, and TRC tests – demonstrate positive benefit/cost ratios (over 1.0) and strong NET benefits (after accounting for costs). Even in the most limited case – where utility costs are balanced against benefits realized directly by ratepayers through lower rates – benefits exceed costs. More generally, the broader tests demonstrate that society overall is better off given the net benefits. Given these results, there is strong justification for the proposed utility EV program which helps jumpstart and seed the market as necessary to achieve the adoption levels that deliver the benefits quantified.

10 Appendix A: Additional Details On Analysis Methodology

Section 4 provided a high level summary of the scope, assumptions, and methodology for the study. Additional details are provided below:

1. Analysis Window: The benefit-cost analysis covers the period 2019-2035. This analysis window is considered appropriate since a) the proposed utility program will be implemented primarily in 2019, but with operating impact thereafter, b) many of the new EVs put into service during the program period will remain in operation over this window, c) many of the customers directly impacted by the utility program will help stimulate additional EV adoption over time (word of mouth, consumer familiarity, growing industry scale and lower costs, etc.), and d) some of the assets implemented by the program – especially public charging infrastructure – will have an operating life through 2035 at least.

2. PEV Adoption: The PEV adoption forecast is based on a) the historical BEV and PHEV sales rates in Delaware, b) extrapolation of sales at 40% for BEVs and 30% for PHEVs, and c) retirement of both BEVs and PHEVs after eight years in service. The overall size of the light duty fleet is not projected to deviate significantly from historical trends as a result of electrification. The assumption of 40% and 30% growth rates is based on comparing key market condition benchmarks for Delaware with other EV adoption states. BEV sales growth year/year averaged 63.3% (2016-2017), and PHEV sales growth averaged 50.0%. Longer term, BEV sales are expected to strengthen as battery prices decline and PHEVs lose their price advantage over BEVs. The PEV forecast assumes continued availability of current incentives, and supportive utility programs that reduce adoption barriers for consumers. The statewide forecast for the DPL-fraction of Delaware was assumed to be 70%, scaled by electricity consumption of the state vs the DPL territory as determined from EIA form 861 and 861S for 2016. This percentage was scaled up slightly to account for the fact that New Castle is within the DPL territory, consistent with population distribution for the state.

3. Savings Basis: Savings will be computed as the difference between total costs WITH EV adoption (as per the adoption profile above) relative to a baseline of "no EVs", which essentially means assuming no additional EVs sold beyond what is already in the market. This method provides an appropriate method of quantifying the impact of EV adoption overall.

4. The overall market simulation is applied against PJM overall, as induced by DPL-DE load. Those consumption results are then scaled to the DPL-DE territory based on the fraction of DPL volume in Delaware. This fraction is computed based on the baseline DPL consumption for 2019 – 2022 (from Aurora) compared with the utility forecast for DPL-DE over the same period. Based on this analysis, 42.62% of PDPL consumption is in Delaware, and this is assumed to be constant over the analysis period.

5. Capacity and Transmission costs based on a forecast by Gabel Associates using data provided by PJM on current and projected capacity costs. Other PJM cost factors taken from PJM references[16].

6. Discount Rate: All Present Value calculations are based on a discount rate of 5.5%.

7. Drive Patterns: Travel statistics, especially regarding average miles traveled per day, are based on the Light Duty Vehicle (LDV) fraction of total VMT[17], including passenger cars, crossovers, SUVs, minivans, and pickup trucks, divided by the number of vehicles in the applicable weight classes, based on publicly available sources[18].

8. Statistics For Traditional Vehicles (Internal Combustion Engines): Existing traditional vehicle performance will be based on the national fleet average (MPG), beginning at 22.1 MPG in 2019[19], and growing by 0.2 MPG annually through the analysis period. MPG for the fueled miles of PHEVs will be based on the average of MPG quoted for PHEVs currently on sale in the U.S. (39.0 MPG, flat through the analysis period).

9. PEV Statistics: Efficiency parameters for PEVs are based on the sales weighted average (YTD 2018) of specifications for vehicles currently on sale in the U.S[20]. This assumes 3.6 miles/kwhr for BEVs in 2019, and 2.63 miles/kwhr for PHEVs in 2019. The BEV efficiency changes slightly over time reflecting duel impacts from a) improving powertrain design, and b) increased penetration of heavier vehicles and form factors. The BEV factor plateaus at 3.9 miles/kwhr in 2025, and the PHEV factor is constant over the period.

10. Charging Segmentation: The same six-segment EVSE segmentation model developed for the ChargEVC-NJ study was used[21].

11. Charge Scheduling: Managed charging will be assumed, based on the same methodologies used in the ChargEVC-NJ study[22]. This profile accounts for charging through all six segments, but forces residential charging to be between 10PM and 7AM. The same schedule is assumed for all years in the analysis window, and for both private and multi-family residents. All days are assumed to be equal regarding both travel and charging (i.e. no distinction for seasonality or day-of-week variations).

12. Cost of Gasoline: $/gallon data for each territory from the price tracking website gasbuddy.com, with extrapolation through 2035 based on EIA projections[23]. The EIA growth rate is used through 2025, but only HALF the EIA growth rate was used from 2026 to 2035 to reflect reduced gasoline prices that are expected to result from EV adoption and reduced petroleum demand.

13. Infrastructure Tax Adders: An operating expense for EV drivers is added that is equivalent to the federal and Delaware gas tax to ensure that infrastructure funding is continued long term. Based on the current gas taxes for Delaware ($0.230/gallon for Delaware, plus $0.184/gallon federal), that rate is $0.0186/mile for an average vehicle (in 2019), declining slightly over time as MPG increases.

14. Vehicle Emissions: Emissions per gallon of gasoline were taken from the 2013 update of the federal MOVES database[24], based on E10 gasoline blend.

15. Economic Value Of Reduced CO_2 Emissions: To determine the economic value of reduced CO_2 emissions, the analysis used the "Social Cost of Carbon for Regulatory Impact Analysis - Under Executive Order 12866" produced by the Interagency Working Group on Social Cost of Greenhouse Gases, United States Government, as updated August 2016. Specifically, the analysis used the "3% Average" case which represents a mid-point of the three primary CO_2 cost scenarios. This analysis, when adjusted to nominal dollars in each year of emissions, provides an economic estimate of the value of avoided CO_2 emissions.

16. Economic Value Of Reduced NOx and SO_2 Emissions: To quantify the benefits of SO_2 and NOx reductions, Gabel reviewed the Environmental Protection Agency (EPA) benefit-cost-analysis associated with the Cross-State Air Pollution Rule (CSAPR), which replaced the Clean Air Interstate Rule as of May 1, 2017 [source: https://www.epa.gov/csapr/presentation-proposed-air-pollution-transport-rule]. EPA's analysis is a very comprehensive assessment of the social costs associated with power plant emissions and the health benefits created by the reduction of those emissions. SO_2 and NOx contribute to ground-level ozone and acid rain and are precursors to the formation of airborne particulate matter, i.e. PM2.5. PM2.5 is too small for human lungs to filter out and causes a wide variety of respiratory illnesses resulting in health care costs, lost workdays, and premature death. Based on this analysis of emissions reductions and their associated health and social benefits, Gabel calculated a $/ton benefits value for both SO_2 and NOx.

17. EV Driver Savings: All EV drivers operating expense savings will be based on the average costs for electricity (plus the gasoline tax replenishment adder), the projected gasoline costs, average vehicle MPG and efficiency, and maintenance costs (for EVs vs. traditional vehicles) as estimated in an independent study by AAA[25].

18. Vehicle Charging Electricity Costs: The model computes the average cost of electricity, across all segments, for each year of the study period, based on the aggregate load curve. When computing vehicle charging costs at home, the residential rate for electricity is used, which is typically several cents/kwhr higher than the overall average. The residential adjustment is based on the most recent data from EIA comparing average electricity rates and residential rates[26].

19. Federal Vehicle Purchase Premium: The vehicle purchase premium for PEVs compared with traditional vehicles is based on a California study on that topic (San Diego Gas and Electric Company, Filing to the California Public Utilities Commission on April 11, 2014, Chapter Six, direct testimony of J.C. Martin). The premium for BEVs and PHEVs in 2018 is assumed to be $9,660 and $8,979 respectively, and declines relatively linearly to zero in 2031.

20. Non-Utility Charging Infrastructure Investments: Vehicle charging infrastructure requirements are based on factors for Delaware from the DOE National Infrastructure study,

September 2017, specifically for Delaware. Both workplace and public L2 plug-count were based on the overall PEV sales rate (BEVs and PHEVs), while public DCFC plug-count was proportional to BEV sales. The factors used were 0.03000, 0.02200, and 0.00387 plugs per relevant vehicle (workplace, public L2, and public DCFC respectively), held constant over the analysis period. Residential L2 chargers were assumed to be needed for 100% of new BEV sales, and 25% of new PHEV sales (many PHEVs, with smaller batteries, can be charged easily overnight with a standard L1 charger, as included with the vehicle).

21. Utility EV program costs include all programs proposed, in aggregate.

End Notes and References

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[1] EV sales taken from the Auto Alliance Advance Technology Vehicle Sales Dashboard: Statistics compiled by the Alliance of Automobile Manufacturers using information provided IHS Markit, Data last updated 4/25/18, retrieved May 2018 from https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/.

[2] EVs are assumed to retire from the fleet after eight years, consistent with most EV warranties being between eight and ten years. Note that although many EVs are leased for shorter periods (typically three years), those vehicles usually remain in the fleet as a used car and are therefore counted as still being in service.

[3] The forecasted blended growth rate of 34.9% is close to the Navigant base case CAGR for Delaware of 37% (through 2027).

[4] American Community Survey for Delaware, 2012-2016.

[5] Delaware Housing Fact Sheet, 2016, from the Delaware State Housing Authority.

[6] Federal Highway Administration, State Statistical Abstracts, for the state of Delaware 2015.

[7] Delaware's 2010 Greenhouse Gas Emissions Inventory, Final Report, prepared by the Division of Air Quality, published February 2014, Delaware Department of Natural Resources and Environmental Control.

[8] Detailed physical infrastructure impact studies were completed for a utility in New Jersey as part of the ChargEVC market opportunity assessment (Electric Vehicles in New Jersey – Costs and Benefits, ChargEVC, principle investigator Mark Warner, Gabel Associates Inc and Energy Initiatives Group LLC, January 26, 2018), and also specifically for the utility infrastructure on Long Island (Electric Vehicles On Long Island – Costs and Benefits, Principle Investigator: Mark Warner, Gabel Associates Inc. and Energy Initiatives Group LLC, May 4, 2018).

[9] Revised and Prepared Direct Testimony of J.C. Martin, Chapter 6, on behalf of San Diego Gas & Electric Company, Application for approval the company's electric Vehicle-Grid Integration Pilot Program, Filed April 11, 2014, Table 6-6.

[10] As a cross-check on these vehicle purchase premium assumptions, prices for the 2018 Hyundai Ioniq were compared. This vehicle is unique in that the EXACT SAME VEHICLE is available in three different drivetrains: basic hybrid (with no plug), a plug-in hybrid (with 28 miles of electric range), and a pure battery electric vehicle (with 118 miles of electric range). This particular vehicle makes it easy to provide a strong apples-to-apples comparison between vehicles that have identical features and differ only by drivetrain. The Ioniq Plug-In Hybrid has an MSRP premium of between $800 and $2,750 depending on trim level, compared with the non-plug-in hybrid. The pure battery electric has an MSRP of between $5,000 and $7,300, depending on trim level, compared with the non-plug-in hybrid. These data points, based on a real vehicle for sale in U.S. market in 2018, substantiates the numbers from the California study (as projected into 2018 and beyond), after accounting for the relatively modest electric range of the Ioniq compared to the average EV range assumed in the analysis (40 miles for the PHEV, at least 200 miles for the BEVs).

[11] National Plug-In Electric Vehicle Infrastructure Analysis, US DOE, Office Of Energy Efficiency and Renewable Energy, September 2017.

[12] California Standard Practice Manual, Economic Analysis Of Demand Side Programs And Projects, California PUC, October 2001. This reference can be found at the online reference below:
http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf

[13] Revised and Prepared Direct Testimony of J.C. Martin, Chapter 6, on behalf of San Diego Gas & Electric Company, Application for approval the company's electric Vehicle-Grid Integration Pilot Program, Filed April 11, 2014.

[14] California Transportation Electrification Assessment, Phase 2: Grid Impacts, October 23, 2014

[15] Cost-Benefit Analysis of Plug-In Electric Vehicle Adoption in the AEP Ohio Service Territory, E3 Consulting, April 2017.

[16] State of the Market Report for PJM, by the Independent Market Monitor, March 08, 2018, Volume 1: Introduction

[17] Federal Highway Authority, Vehicle Miles Traveled by functional system, by State (Table VM-2), years 2007 – 2016.

[18] Federal High Administration, Table MV1, Vehicle Registrations 2016

[19] On-Road Fuel Economy of Vehicles in the United States: 1923 – 2015, Michael Sivak and Brandon Schoettle, University of Michigan, Report No SWT-2017-5, March 2017

[20] PEV performance statistics based on an analysis by Gabel Associates of all PEVs for sale in the US market as of the end of 2017, based on specifications published by vehicle manufacturers. All range specifications are based on EPA ratings for each vehicle.

[21] Electric Vehicles In New Jersey, Costs and Benefits, Prepared for ChargEVC by Gabel Associates Inc, Mark Warner, January 26, 2018

[22] Real world time-of-day charging distributions for each of the charging segments was collected from industry partners in the ChargEVC coalition. This information was augmented by research from UC Davis, Institute of Transportation Studies, Working Paper – UCD-ITS-WP-13-01, "California Statewide Charging Assessment Model of Plug-In Electric Vehicles: Learning from Statewide Travel Surveys:, January 2013, Michael A Nicholas, Gil Tal, Justin Woodjack.

[23] EIA 2018 Energy Outlook, forecast of nominal price of motor gasoline use in the transportation sector (national average). This information was scaled from national average pricing to state-specific pricing using information from the EIA State Profiles, Table E16, Motor Gasoliine Price and Expenditure Estimates, Ranked by State, 2015.

[24] Updated Emission Factors of Air Pollutants from Vehicle Operations in GREET Using MOVES, Hao Cai, Argonne National Laboratory, Energy Systems Division, September 2013.

[25] Your Driving Costs, American Automobile Association, 2017 Edition

[26] Energy Information Agency, Electric Power Monthly, published February 2018 with data through December 2017, Table 5.6.B.

Exhibit C

NATIONAL ASSOCIATION OF STATE UTILITY CONSUMER ADVOCATES

Resolution 2018 - 02

URGING THE ADOPTION OF POLICIES AND REGULATIONS TO PROTECT RATEPAYERS AS ELECTRIC VEHICLE ADOPTION RATES INCREASE

Whereas, the rate of adoption of electric vehicles[1] that utilize electricity from the grid to charge, whether at home, at a workplace, or at a charging station, is increasing;[2] and

Whereas, the purchase of electric vehicles may impact utilities' decisions regarding distribution system investments, the development of proposals for charging system infrastructure investment, and rate structures, and therefore may impact the electric rates paid by both electric vehicles owners and other ratepayers; and

Whereas, some project that electric vehicle adoption will continue to increase rapidly,[3] with some even projecting that 50% of new car sales in 2040 will be electric vehicles;[4] and

Whereas, electric vehicles add to overall electric load, but when coupled with effective consumer education, incentives, and rate design, might serve to mitigate the impact of electric vehicle charging on ratepayers through additional electric revenue and reducing the effect of electric vehicle charging on existing grid resources through peak shaving and shifting demand to times when capacity is plentiful; and

Whereas, some states and municipalities have adopted goals and plans to increase the adoption rate for electric vehicles to reduce the transportation sector's contribution to greenhouse gas emissions, without specifying the nature of the role of the public utility in electric vehicle adoption and whether ratepayers should be financially responsible for infrastructure investments;

Whereas, the core responsibilities of any public utility remain the same with the addition of any new load, including electric vehicle load, on a distribution system, which are to maintain the safety, reliability, and affordability of the electric system for the benefit of its ratepayers;

Whereas, some policymakers, utilities, and electric vehicle advocates are proposing various utility roles in order to promote electric vehicle adoption including rapid expansion in the electric vehicle

[1] In this resolution, the term "electric vehicles" refers to both all-electric vehicles and plug-in electric hybrid vehicles.

[2] For instance, according to the Atlas EV Hub, the amount of U.S. electric vehicles purchased has increased from about 18,000 in 2011 to about 195,000 in 2017. Based on the most recently available quarterly data, about 54,000 electric vehicles were purchased between January 1, 2018 and March 31, 2018 as compared to about 41,000 electric vehicles purchased during the same time period in 2017. *See* atlasevhub.com for additional information (the national EV sales data is from HybridCars.com, *available at* http://www.hybridcars.com/market-dashboard).

[3] February 2018 of the Edison Electric Institute entitled "Accelerating Electric Vehicle Adoption," available at: http://www.eei.org/issuesandpolicy/electrictransportation/Documents/Accelerating_EV_Adoption_final_Feb2018.pdf

[4] *See, e.g.,* Bloomberg New Energy Finance's report entitled "Electric Vehicle Outlook 2018," which projects that 55% of new car sales in 2040 will be electric vehicles, and that at that point 33% of the global auto fleet will be electric.

charging infrastructure,[5] potentially funded at least in part by the ratepayers; and

Now, therefore, be it resolved, that NASUCA encourages states to continue to evaluate and analyze key electric vehicle adoption issues with an emphasis on the core responsibilities of public utilities, a specific focus on the efficient integration of electric vehicles and charging infrastructure into their systems, the avoidance of adverse impacts on the system from electric vehicle loads, the development of alternative rate designs if appropriate, the adaptation of distribution planning to minimize system risks and provide the opportunity for longer term system and cost benefits for their ratepayers, and the equitable sharing of any costs and benefits;

Be it further resolved, that NASUCA encourages dialogue in each state among stakeholders with the goal of developing consensus policy solutions for electric vehicles that protect the interests of all ratepayers; and

Be it further resolved, that NASUCA recommends, in accordance with and to the extent allowed by federal and state laws, that neighboring states should work jointly together on developing compatible regional policies; and

Be it further resolved, that while policy design may differ between states, NASUCA maintains that managing the demand of electric vehicle owners for electricity with the goal of creating a more efficient, reliable, equitable, environmentally responsible, and less costly electric system should be at the center of all electric vehicle policy discussions; and

Be it further resolved, that NASUCA maintains, to the extent the transportation system electrifies, it will be important to recognize that charging patterns will impact system load shape and could result in costs or benefits to the utility system. Accordingly, NASUCA encourages states to consider developing tools like time-based rate options or other appropriate rate designs for customers charging electric vehicles, separate tariffs for electric vehicle charging, smart charging programs where the utility and customers coordinate to shift electric vehicle charging loads to appropriate times, load management practices, demand response, and other innovative applications, such that electric vehicle loads will be managed in the interest of all ratepayers; and

Be it further resolved, that NASUCA maintains that any rate options, rate design changes, applications developed for customer use, or any other utility-related programs for electric vehicle owners must be accompanied by appropriate consumer protections, including robust consumer education materials and data privacy requirements and to the extent they would be adversely affected additional protections for disadvantaged or low income ratepayers; and

Be it further resolved, that NASUCA maintains that any utility proposals to develop electric vehicle infrastructure through ratepayer charges must be supported by a rigorous analysis of the benefits and costs for the ratepayer, including the benefits and costs for disadvantaged or low-income ratepayers, with each state determining the type and scope of the benefits, costs and risks that are taken into account; and

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[5] *Id.*

Be it further resolved, that NASUCA recommends states consider whether public utility involvement in the development of electric vehicle charging stations might limit entrance or competition that might otherwise benefit consumers and whether that involvement might cause ratepayers to take on risks that could or should more appropriately and cost-effectively be borne by private enterprise; and

Be it further resolved, that NASUCA maintains that any utility proposals to promote electric vehicle adoption and/or develop electric vehicle infrastructure through ratepayer investments must leverage all related private, state and federal funding sources; and

Be it further resolved, that NASUCA recommends to protect monopoly distribution customers from subsidizing competitive services that any tariffs for electric vehicle charging should be cost-based, without reliance on cross-subsidies from other ratepayers; and

Be it further resolved, that NASUCA recommends the costs associated with the promotion and development of the electric vehicle industry be borne by the transportation sector, consistent with principles of cost causation; and

Be it further resolved, that for electric vehicle charging stations supported by utility rates, NASUCA encourages policies that ensure compatibility with all commercially available makes of electric vehicles; and

Be it further resolved, that NASUCA authorizes its Executive Committee to develop specific positions and to take appropriate actions, including litigation, consistent with the terms of this resolution. The Executive Committee shall advise the membership of any proposed action prior to taking such action, if possible. In any event, the Executive Committee shall notify the membership of any action taken pursuant to the resolution.

Submitted by the DER Committee and the Electric Committee

Adopted by the Membership
Minneapolis, Minnesota
June 24, 2018